UNEP

industry and environment

ISSN 0378-9993
Industry and Environment
Volume 23
Special Issue 2000

A publication of the United Nations Environment Programme
Division of Technology, Industry and Economics

Une publication du Programme des Nations Unies pour l'environnement
Division Technologie, Industrie et Economie

Una publicación del Programa de las Naciones Unidas para el Medio Ambiente
División de Tecnología, Industria y Economía

Mining and sustainable development II

Challenges and perspectives

- Environmental stewardship
- Risk communication
- Voluntary codes
- Emergency preparedness

Industry and Environment is a quarterly review published by the United Nations Environment Programme Division of Technology, Industry and Economics (UNEP DTIE), Tour Mirabeau, 39-43 quai André-Citroën, 75739 Paris Cedex 15, France. Tel: +33 01 44 37 14 50; Fax: +33 01 44 37 14 74; E-mail: unep.tie@unep.fr; http://www.uneptie.org

Director
Jacqueline Aloisi de Larderel

Editorial Staff
Wanda Hoskin
Geoffrey Bird
Thalia Stanley

Editorial Policy
The contents of this review do not necessarily reflect the views or policies of UNEP, nor are they an official record. The designations employed and the presentation do not imply the expression of any opinion whatsoever on the part of UNEP concerning the legal status of any country, territory or city or its authority, or concerning the delimitation of its frontiers or boundaries.
The non-copyrighted contents of this review may be reprinted without charge provided that **Industry and Environment** and the author or photographer concerned are credited as the source and the editors are notified in writing and sent a voucher copy.

Industry and Environment welcomes for pos- sible publication feedback from readers, news on their sectors of activity, or articles. The editors cannot guarantee publication nor return of unsolicited manuscripts, photographs and artwork. Manuscripts which do not conform to the conventions and standards of the review may be returned for revision.

Subscriptions
Industry and Environment is subject to an annual subscription fee of US$ 60.00. See back page for order form. Upon application to the Director, submitted on letterhead, the annual subscription charge may be waived for government, educational and non-profit organizations in developing countries who are unable to remit payment.

This review is printed on 100% chlorine free paper.

Contents
Mining and sustainable development

4 Mining – facts, figures and environment
8 Who's who in mining / environment
10 The global mining industry – *by Chris Hinde*
14 Financing and sustainability
15 Fundamental Principles for the Mining Sector (Berlin Guidelines 1991, revised 1999)
16 Challenges to sustainable development in the mining sector – *by Deborah J. Shields and Slavko V. Solar*

Environmental management and global reporting

20 The Global Reporting Initiative – an opportunity for the mining industry – *by Robert K. Massie, Allen White and Nancy Bennet*
24 Mineral Resources Forum – Environment
25 Mining Industry Report Comparison
26 Mining and sustainable development: associations hold key to programme of change – *by Anita Roper*
29 Some environmental management tools for mining – a brief overview

Environmental issues

32 Sustainable development and the evolving agenda for environmental protection in the mining industry – *by Barry Carbon*
36 Abandoned mine sites: problems, issues and options
38 Training small scale miners: the video project – *by Grant Mitchell*
39 Rehabilitation measures: water management
Rehabilitation measures: tailings impoundment

Environmental and toxicity issues

40 Biodégradation/persistance et bioaccumulation/biomagnification des et des composés métalliques
41 Future challenges facing the mining industry: an environmental health perspective – *by Michael R. Moore and Barry N. Noller*

Economic issues

44 Mining and the environment: the economic agenda – *by Olle Östensson*
47 Environmental impacts of trade liberalization and policies for the sustainable management of natural resources: A case study on Chile's mining sector
49 Small-scale and artisinal mining
50 Small-scale mining legislation and regulatory frameworks – *by Edmund Bugnosen, John Twigg and Andrew Scott*
54 Financial provisioning for mine closure: developing a policy and regulatory framework in the transition economies – *by Mehrdad M. Nazari*

Social issues

57 Mining and the Social Imperative – *by Nola-Kate Seymoar*
60 The dialogue between environmental and community groups and the mining industry in South Africa – *by Julie Courtnage, John Kilani, Andrew Parsons and Doctor Mthethwa*
62 If you give you must always expect twice in return – a South African's experience in Canada– *by Grant Mitchell*
63 Mining and Indigenous Peoples – *by P. Jerry Asp*

Tailings and waste

64 Dissection of an accident: lessons learned and follow-up actions from Baia Mare
65 Summary of major mining-related environmental incidents since 1975
66 Tailings accidents and lessons learned
68 Emergency Preparedness and Response: APELL for Mining
71 The case for auditing and certification of tailings management facilities – *by Stewart Cale and Mike Cambridge*
73 Prevention of hazards in mining tailings dams and waste heaps – *by Kazunori Kano*
76 Designer waste – *by Hugh Jones*
78 Environnement minier : résidus de l'industrie minière et alternatives de valorisation – *by G. Morizot, H. Lesueur et H. Zeegers*

Voluntary non-regulatory and regulatory initiatives

83 Voluntary initiatives: improving environmental performance
84 International Conventions and Guidelines Affecting Mining
86 Mining Minerals and Sustainable Development (MMSD) Project – *by Luke Danielson*
86 Accident prevention and environmental sefety in mining: the role of governments

Viewpoints on future challenges

87 Environment, multi-culturalism and human rights: challenges for the mining industry and governments – *by Cristina Echavarría*
88 Mining and World Heritage considerations – *by Mechtild Rössler*
90 Mining and protected areas: an IUCN viewpoint – *by Adrian Phillips*
92 La minería en la encrucijada de la sustentabilidad – *by Adam Rankin and Hildebrando Velez*
93 Future challenges for the large-scale mining industry – *by Amy Rosenfeld Sweeting*
94 Mining and metals processing: The commitment to sustainable development – *by Gary Nash*

Editorial

Mining and sustainable development: challenges for the next decade

Activities related to mining and sustainable development have been an important part of UNEP's work for a number of years. This is, in fact, the second issue of Industry and Environment devoted to the subject. The environmental effects of the mining industry include destruction of natural habitats, changes in river regimes and water tables, and other serious ecological impacts. Although the industry has succeeded in making improvements, serious problems remain, beginning with the need to reduce the number and severity of accidents.

The January 30 mine tailings accident in Baia Mare, Romania, resulted in a cyanide plume that crossed four countries entering the Danube. UNEP and the UN Office for the Coordination of Humanitarian Affairs (OCHA) led an assessment mission to the region and their final report has helped focus several of UNEP's mining related initiatives this year. In China, too, 23 mining related accidents have been reported this year including five tailings dam failures.

As part of its work on improving environmental performance, UNEP has undertaken several critically important initiatives with various partners. Due to problems associated with cyanide use, it initiated the development of an industry cyanide code for its use in gold mining with the International Council on Metals and the Environment. This code should be adopted in 2001. An APELL for Mining handbook, aimed at reducing the risk of accidents and developing local emergency preparedness should an accident occur, will be available in early 2001. With the International Commission on Large Dams, UNEP has stressed the importance of introducing contingency measures to ameliorate the impact of tailings dam incidents at the design stage. With the government of Australia, UNEP recently hosted an international workshop (in which some 20 countries participated) to promote more effective regulation of mining's potentially hazardous aspects. Moreover, since mining companies are heavily capitalized, UNEP is encouraging financial institutions including the World Bank Group to play a greater role in fostering sustainable mineral development. As one important tool for making information freely available, UNEP uses the Environment section of the Mineral Resources Forum website initiated by the United Nations Conference on Trade and Development (UNCTAD).

Availability of water is likely to be one of the 21st century's most pressing resource issues. All but a handful of countries in which mining takes place (e.g. Canada, Norway and Sweden) are vulnerable to water scarcity. Growing populations, and other industries, compete with the mining industry for a share of this resource. UNEP has been working with the International Council on Metals and the Environment on a best practice case study book concerning water management at mining sites.

UNEP is also addressing other mining related issues, including energy demand, abandoned sites, biodiversity and protected areas and the use of hazardous chemicals. Under the rubric of cleaner production, UNEP's broad objective is to phase out the production and use of persistent and bioaccumulative substances, including heavy metals, which affect human health and the environment.

UNEP is dedicated to helping the mining industry achieve its ambitious environmental and social targets. To succeed, we believe a policy mix including regulatory measures, economic incentives and voluntary initiatives will be necessary. The Malmö Declaration of the first Global Ministerial Environment Forum, convened by UNEP in May 2000, stated that: "The private sector has emerged as a global actor that has a significant impact on environmental trends through its investment and technology decisions. In this regard, Governments have a crucial role in creating an enabling environment. The institutional and regulatory capacities of Governments to interact with the private sector should be pursued to engender a new culture of environmental accountability through the application of the polluter-pays principle, environmental performance indicators and reporting, and the establishment of a precautionary approach in investment and technology decisions."

Early in 2000, the Global Mining Initiative (GMI) was launched by over 25 CEOs of the world's largest mining companies to examine the range of current issues and ensure that the industry and other stakeholders will work together to contribute to sustainable economic development patterns. GMI initiated the Mining Minerals Sustainable Development (MMSD) project as an independent process of multi-stakeholder engagement and analysis, with the objective of "identifying how mining and minerals can best contribute to the global transition to sustainable development." As Kofi Annan, the UN Secretary General, has said: "Transnational companies have been the first to benefit from globalization. They must take their share of the responsibility for coping with its effects."

That such accountability and transparency go together with environmental reporting has been consistently advocated by UNEP. It is one of the co-convenors of the Global Reporting Initiative (GRI), along with the Coalition for Environmental Responsible Economies (CERES) and with the support of the United Nations Foundation. GRI is a long-term, multi-stakeholder international undertaking to develop globally applicable sustainability reporting. Its objective is to raise sustainability reporting to the same level of acceptance and consistency as financial reporting.

In the lead-up to Rio+10 in 2002, UNEP is reviewing the mining industry's environmental performance and management systems, as well as the use of voluntary agreements to complement government regulatory initiatives.

The mining industry faces many challenges in the coming years. This issue of Industry and Environment presents the viewpoints of different stakeholders, thus helping to define both challenges and possible solutions. The mining industry's commitment to sustainable mineral development needs to continue to evolve, in order to meet these challenges effectively.

◆

Mining – facts, figures and environment

Introduction

The forward-looking articles in this millennium issue of *Industry and Environment* do not describe the mining industry or its environmental impacts in great detail. Since many readers are probably not well acquainted with this industry, however, the "Facts, Figures and Environment" section will provide some background. A number of technical terms used in the articles that follow are also explained.

Part I: Mining – what, where and how?

What is mining?

A working definition of mining could simply be "the extraction of minerals from the earth". The word "minerals" in this case would cover a wide variety of naturally occurring substances extracted for human use. Although this definition is adequate for our purposes, mining can also be seen as a process that begins with the exploration for and the discovery of mineral deposits and continues through ore extraction and processing to the closure and remediation of worked-out sites (Figure 1). Environmental impacts occur at all of these stages. Although the articles in this issue are mainly concerned with the extraction and processing stages, there are serious environmental issues surrounding mine closure, post closure monitoring and abandoned mine sites.

Minerals are usually classified in four main groups: *metals; industrial minerals* (such as lime or soda ash, valued for certain special properties), *construction materials* and *energy minerals* (i.e. coal, natural gas, oil, etc.). Over 4.6 billion tonnes of coal were mined in 1998. Table 1 gives production figures for selected mineral commodities in 1998–1999. The minerals extracted in the greatest quantities (but not shown in this table) are those used in construction. It is estimated that some 13 billion tonnes of stone, 10 billion tonnes of sand and gravel, and 500 million tonnes of clay are used annually. With the rapidly growing world population and increasing construction these figures are expected to increase.

Where are minerals mined?

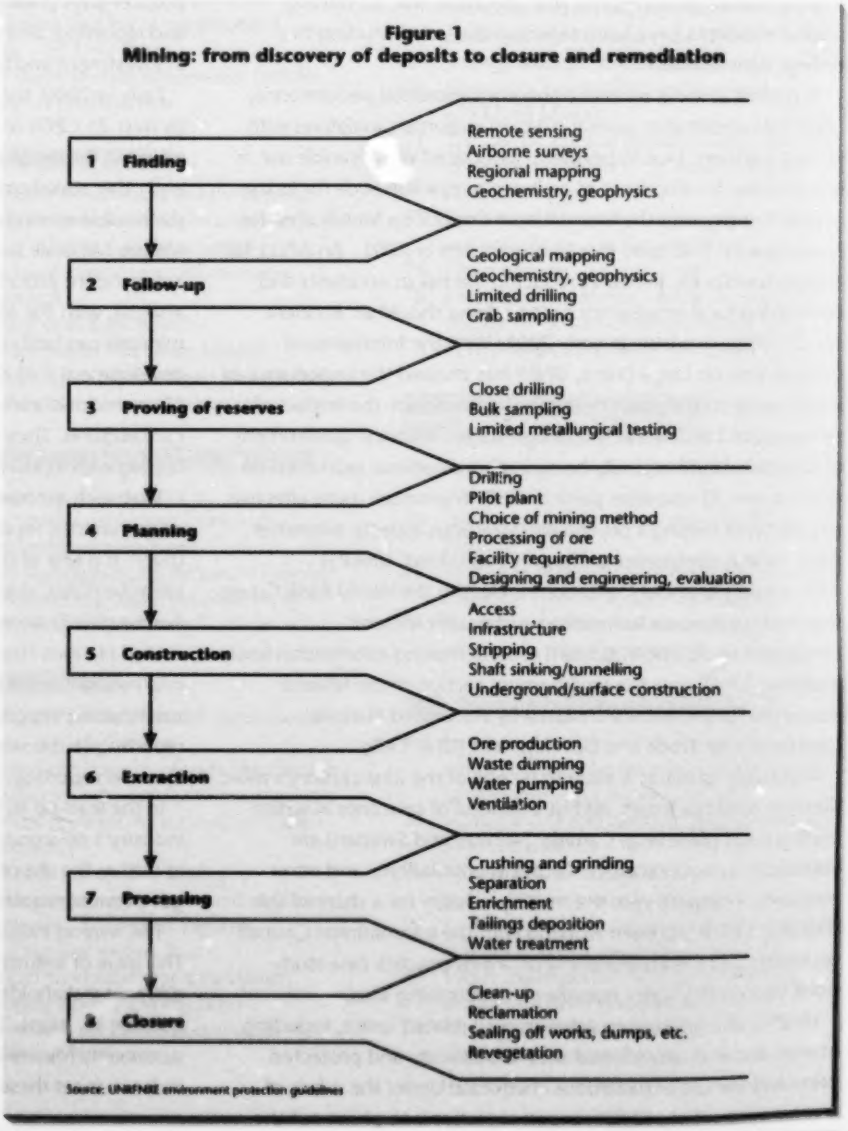
While minerals are mined throughout the world, the London Mining Journal 1999 Annual Review detailed 158 countries for whom mining is a significant contributor to the national economy. Major metal production areas are shown in Figure 2. As has been the situation for many years, a high proportion of minerals are mined in poorer countries but consumed in richer ones. The world's largest mining companies are listed in Table 2.

How are minerals obtained?

Once a commercially viable mineral deposit has been identified, the immediate problem is how to get it out of the ground. There are essentially two ways of doing this: by *open pit mining* and *underground mining*. An open pit is a surface excavation, usually conical in shape, dug for the purpose of extracting near-surface ore bodies. The rock overlying the ore body, called the *overburden*, is drilled and/ or blasted and loaded into trucks that carry it away from the pit. The ore body is then removed for initial processing. Most mines today are surface excavations.

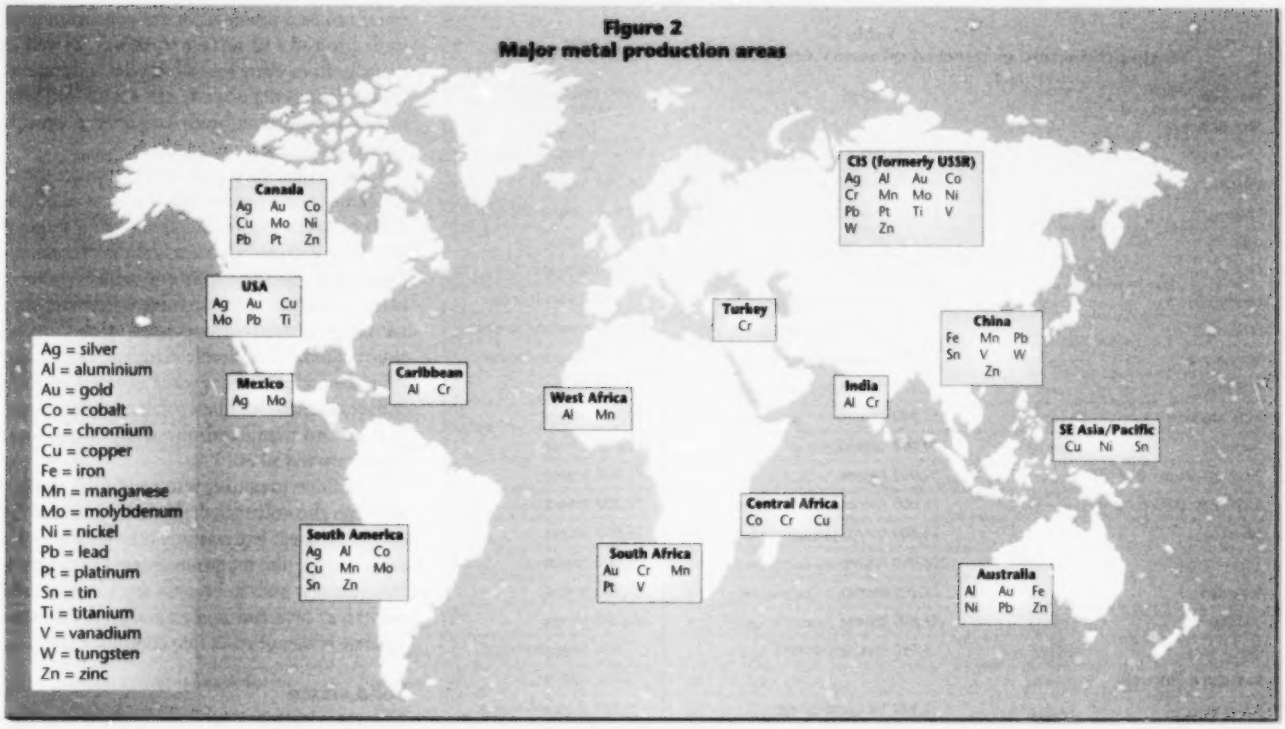
Underground mining, which takes place when minerals lie deep beneath the surface, is only economical for high grade ore bodies (see below). To get to the ore body, a vertical shaft, horizontal entrance or passage (adit), or inclined passageway (winze) must be drilled for ore and waste removal.

Figure 1
Mining: from discovery of deposits to closure and remediation



Source: UNEP/IE environment protection guidelines

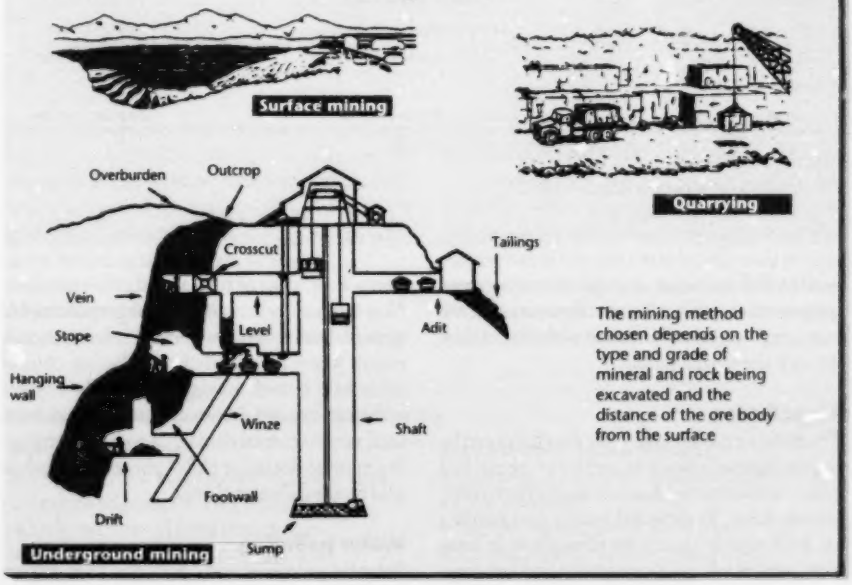
Figure 2
Major metal production areas



as well as to provide ventilation. Figure 3 illustrates these different types of underground mining, along with some technical terms.

Placer mining is a widely used technique for extracting precious metals from sand or gravel deposits at or near the surface. The sand or gravel is mixed with water which is then agitated so that the metals sink. The lighter unwanted material is then washed away. Panning for gold is a simple, small-scale example of placer mining.

Figure 3
Mining methods



Processing

For some minerals, such as those used in construction, processing is usually limited to washing and separation. For others, especially metallic ores, processing may involve a number of chemical and physical separation steps that can have serious implications for the environment. The most widely used of these processes are described below.

The sought-after ores (known as the *values*) must be separated from the less valuable or valueless material in which they are found, known as the *gangue*. The amount of mineral contained in the removed material, expressed either as a percentage or by weight, is known as the *grade* of an ore. A productive economic ore body can range from a few pounds per million (gold) to a few percentage points (lead, zinc) or higher (e.g. 17 per cent for potash; 30 per cent for manganese; 40 per cent for iron). The remainder is waste. To clarify what this means: 1000 tonnes of ore at an average grade of 0.91 per cent will result in 9 tonnes of metal and 990 tonnes of waste.

The first step in processing most often consists of crushing or grinding. The combined wastes generated by extraction and milling are known as *tailings*. The entire process of crushing, grinding, sizing, and separation of ore into waste and value is often called *beneficiation*. After the mineral grains have been liberated in this way, they can be physically separated using one of several methods: magnetic separation, gravity methods or chemical methods. The magnetic and gravimetric methods do not generally present environmental hazards, but the chemical methods do. The most common chemical methods are *flotation, cyanidation, amalgamation* and *heap leaching*. These methods use large amounts of organic compounds, cyanide, mercury and acids (frequently sulphuric), all of which need to be properly handled and are frequently found in the tailings.

Part II: Environmental impacts of mining

Given the scale of mining activities, it is not surprising that they have a wide range of environmental impacts at every stage of operations. Potential environmental problems associated with mining projects are listed in Table 3. Some can be

Table 1
World production of selected mineral commodities in 1998 and 1999

Mineral	1998	1999 (estimates)
Metals		
Chromite*	12,700 thousand tonnes	12,800 thousand tonnes
Cobalt*	26,300 tonnes	28,300 tonnes
Copper	12,200 thousand tonnes	12,600 thousand tonnes
Gold	2,460 tonnes	2,330 tonnes
Indium	230 tonnes	240 tonnes
Iron ore	1,020 million tonnes	992 million tonnes
Lead	3,100 thousand tonnes	3,040 thousand tonnes
Manganese	3,090 thousand tonnes	2,910 thousand tonnes
Mercury*	2,320 tonnes	2,300 tonnes
Molybdenum	135,000 tonnes	129,000 tonnes
Nickel	1,140,000 tonnes	1,140,000 tonnes
Platinum group metals (PGM)	269.000 tonnes	275,000 tonnes
Rare Earths (REO content)	76,600 tonnes	76,500 tonnes
Silver*	16,400 tonnes	15,900 tonnes
Tin	206,000 tonnes	210,000 tonnes
Tungsten	32,200 tonnes	31,300 tonnes
Vanadium	41,800 tonnes	40,000 tonnes
Zinc	7,550 thousand tonnes	7,640 thousand tonnes
Industrial Minerals		
Asbestos	1,840 thousand tonnes	1,790 thousand tonnes
Cement	1,520,000 thousand tonnes	1,560,000 thousand tonnes
Fluorspar	4,4670 thousand tonnes	4,220 thousand tonnes
Gypsum	107,000 thousand tonnes	108,000 thousand tonnes
Potash (K2O equivalent)	25,100 thousand tonnes	25,200 thousand tonnes
Salt	186,000 thousand tonnes	200,000 thousand tonnes
Sulphur (all forms)	57,800 thousand tonnes	55,900 thousand tonnes
Energy Minerals		
Coal (all types)	4,655,234 thousand tonnes	data not available

* World total does not include estimates from output from China
Tonnes = metric tonnes
PGM includes platinum and palladium only
Principal source: United States Geological Survey

prevented if there is an appropriate management system; others, such as habitat destruction at the mine site, can generally be dealt with after closure through site rehabilitation.

Air pollution

The main air quality issue is the dust produced by the working of open pits and by crushing and grinding operations. Dust can also be given off by tailings dams. Workers and nearby communities can be affected by dust in the atmosphere. In addition, particle fall-out around mine sites can contaminate soils and water and damage vegetation.

Mines are also sources of greenhouse gas emissions. CO_2 is produced by energy use and methane is sometimes released from underground operations, especially in coal mines. In the past, some deep mines used ozone-depleting CFCs in refrigeration systems. This practice has now largely ceased.

Smelting (the process in which ore is heated for the purpose of separating it from the gangue) produces very large amounts of air pollutants. Worldwide, the smelting of copper and other non-ferrous metals releases an estimated 6 million tonnes of sulphur dioxide (SO_2) into the atmosphere each year – 8 per cent of total worldwide emissions. Non-ferrous smelters also emit large quantities of arsenic, lead, cadmium and other heavy metals except where highly efficient pollution control equipment is used. Smelters may also be regional pollution "hot spots", whose emissions cause severe local environmental damage as well as contributing to more distant or global phenomena such as acid rain and climate change.

Water pollution

Potential sources of water pollution from mining include drainage from surface and underground mines, wastewater from beneficiation, and surface run-off. A particular problem is *acid mine drainage*. Many mining operations, especially those extracting ores that contain sulphides, such as nickel, copper, iron, zinc, cadmium, lead and coal (if pyrites are present), may produce acidic and metal-bearing solutions resulting from the natural oxidation of the sulphides through exposure to air and water. The combination of acids and metals can have severe effects on the ecology of local watercourses, and the metals can enter and *bioaccumulate* up the food chain. Acid mine water can be a problem for drainage from both underground and surface workings, as well as drainage from waste rock stock piles and concentrator tailings deposits. It can occur while the mine is operating and even long after its closure, unless specific measures are taken.

Mineral separation processes that make use of dangerous and toxic chemicals such as sulphuric acid or cyanide (e.g. leaching) or organic reagents (e.g. flotation) can be serious sources of contamination if appropriate control systems are not in place. Furthermore, much mine wastewater contains large amounts of suspended solids (ranging from colloidal to settleable materials) originating from the ore itself, from waste material, or from surface installations. These solids can affect aquatic flora and fauna and physically choke local waterways and lakes.

In addition to causing water pollution, excavations can also influence the hydrology around the excavated area. Excavations may lead to more rapid seepage into the groundwater, causing nearby streams or wells to become dry. Underground works may cut across aquifers and bring otherwise separate bodies of water into communication.

Solid waste

Open pit operations produce far more waste per tonne of ore than underground operations, where there is no overburden and where some of the removed material can be used to backfill excavations as work progresses. Heaps of mine waste occupy large amounts of land and disfigure the landscape. They are also a source of dust and water pollution. Inert material carried away in run-off water can clog rivers and streams. If the wastes contain sulphides, acid drainage can occur – sometimes for many years – due to reaction with rainwater,.

Tailings

The tailings that remain after extraction and processing are mostly muds and slurries containing a very high proportion of extremely finely ground material. Due to their vast quantities, liquid nature and very high content of fines (finely crushed coal or ore), their containment and control are an ongoing management concern at virtually all mine sites (see related articles in this publication).

The separation processes used for most metals do not extract all of the minerals present. Tailings therefore contain quantities of metals and other minerals, as well as residues of the chemicals used to extract them. The finely ground material from processing makes contaminants formerly bound up in solid rock (such as arsenic, cadmium, copper, lead and zinc) accessible to water. Acid drainage, which exacerbates contamination by heavy metals, is often a problem when tailings are exposed to the atmosphere. It arises from the sulphide minerals that are often associated with the commonly mined ores of many metals including copper, gold, lead, nickel and zinc.

Tailings are therefore more usually dumped in heaps, released into ponds, or retained by tailings dams. In some cases, submarine disposal or release

Table 2
The world's 50 largest mining companies

Rank	Name	Country	Approx. Share of total value (1998, %)	Rank	Name	Country	Approx. Share of total value (1998, %)
1	Anglo American Corp of South Africa Ltd.	South Africa	6.68	26	MIM Holdings Ltd.	Australia	0.75
2	Rio Tinto plc	UK	5.02	27	Mistui & Co Ltd.	Japan	0.74
3	Broken Hill Pty Co Ltd.	Australia	3.69	28	Homestake Mining Co.	USA	0.72
4	Cia Vale do Rio Doce Ltd.	Brazil	3.53	29	IMC Global Inc.	USA	0.72
5	State of Chile (Coldeco and Enami)	Chile	2.21	30	Billiton plc	UK	0.70
6	Freeport McMoran Copper & Gold Inc.	USA	1.90	31	Cia Auxiliar de Empresas de Mineracao	Brazil	0.65
7	State of India (various)	India	1.77	32	Arbed SA	Luxemb.	0.65
8	Noranda Inc.	Canada	1.27	33	State of Sweden (LKAB)	Sweden	0.62
9	Phelps Dodge Corp.	USA	1.25	34	State of Venezuela	Venez.	0.62
10	Newmont Mining Corp.	USA	1.16	35	Lonmin plc	UK	0.60
11	Placer Dome Inc.	Canada	1.15	36	Normandy Mining Ltd.	Australia	0.59
12	North ltd.	Australia	1.06	37	Hanson PLC	UK	0.58
13	Gold Fields Ltd.	South Africa	1.05	38	BASF AG	Germany	0.55
14	WMC Ltd.	Australia	1.02	39	Thyssen Stahl AG	Germany	0.54
15	Teck Corporation	Canada	0.98	40	Trans-World Metals SA	Switzerl.	0.51
16	Barrick Gold Corp.	Canada	0.96	41	Glencore International AG	Switzerl.	0.48
17	Inco Ltd.	Canada	0.95	42	State of Zambia (Zimco, ZCCM)	Zambia	0.48
18	Asarco Inc.	USA	0.92	43	Alcoa	Zambia	0.48
19	Potash Corp of Saskatchewan Inc.	Canada	0.90	44	Boliden Ltd.	Canada	0.43
20	State of Botswana (Debswana and BCL)	Botswana	0.85	45	USX Corp.	USA	0.42
21	Iscor Ltd.	South Africa	0.83	46	State of Iran	Iran	0.42
22	State of Morocco (OCP and BRPM)	Morocco	0.82	47	State of Indonesia (mainly PT Timah)	Indonesia	0.42
23	Cyprus Amax Minerals Co.	USA	0.80	48	Cia Siderurgica Nacional	Brazil	0.42
24	Grupo Industrial Minera Mexico SA de CV	Mexico	0.76	49	Israel Chemicals Ltd.	Israel	0.41
25	Gencor Ltd. South	Africa	0.75	50	Industrias Penoles SA de CV	Mexico	0.40

Source: Who owns Who in Mining 2000

directly into rivers occurs. This avoids acid generation but introduces large amounts of suspended solids and contaminants directly into aquatic habitats. Tailings dams, the most common form of disposal, can be large engineering works. The "World Register of Mine and Industrial Tailings Dams" lists eight higher than 150 metres, 22 higher than 100 metres and 115 higher than 50 metres. Six impoundments are known to have a surface area greater than 100 km^2 and a storage volume over 50,000,000 m^3. Experience has shown that tailings dams represent a potentially serious safety and environmental hazard. Table 4 gives details of some recent mining related accidents including tailings dam tailures.

Abandoned Mine Sites

In countries with a long mining history, the magnitude of the impacts from past mining activity is often considerable as environmental concerns and environmental regulation of mining activities has, in most cases, only recently been introduced. While precise definitions may vary, *abandoned* and *orphan* mines refer to mine sites and mineral operations that are: no longer operational; not actively managed; not rehabilitated; causing significant environmental or social problems; and,

Table 3
Some Potential Environmental Impacts of Mining

Environmental Impacts
- Destruction of natural habitat at the mining site and at waste disposal sites
- Destruction of adjacent habitats as a result of emissions and discharges
- Destruction of adjacent habitats arising from influx of settlers
- Changes in river regime and ecology due to siltation and flow modification
- Alteration in water-tables
- Change in landform
- Land degradation due to inadequate rehabilitation after closure
- Land instability
- Danger from failure of structures and dams
- Abandoned equipment, plant and buildings

Pollution Impacts
- Drainage from mining sites, incl. Acid mine drainage and pumped mine water
- Sediment run-off from mining sites
- Pollution from mining operations in riverbeds
- Effluent from minerals processing operations
- Sewage effluent from the site
- Oil and fuel spills
- Soil contamination from treatment residues and spillage of chemicals
- Leaching of pollutants from tailings and disposal areas and contaminated soils
- Air emissions from minerals processing operations
- Dust emissions from sites close to living areas or habitats
- Release of methane from mines

Occupational Health Impacts
- Handling of chemicals, residues and products
- Dust inhalation
- Fugitive emissions within the plant
- Air emissions in confined spaces from transport, blasting, combustion
- Exposure to asbestos, cyanide, mercury or other toxic materials used on-site
- Exposure to heat, noise, vibration
- Physical risks at the plant or at the site
- Unsanitary living conditions

Table 4
Accidents: are we making progress on sustainable mineral development? You judge.

The following are some mining-related accidents reported in the media from January to November 2000. Many others may go unreported.

Date	Location	Type of incident	Chemical	Deaths and other consequences
30 Jan. 2000	Baia Mare, Romania	Tailings dam crest failure after overflow during the time of heavy rain and melting snow	Cyanide	No deaths
10 Mar. 2000	Borsa, Romania	Tailings dam failure after heavy rain	Heavy metals	No deaths
21 March 2000	Tolukuma, Papua New Guinea	Transportation Accident (Helicopter)	Cyanide	No deaths
02 Jun. 2000	Cajamarca, Peru	Transportation Accident (Truck)	Mercury	0 (17) death
24 Jul. 2000	Romania	Pipe line failure	Zinc and lead	No deaths
9 Sep. 2000	Gällivare, Sweden	Tailings dam failure from failure of filter drain	Copper	No deaths
14 Sep. 2000	Tolukuma, Papua New Guinea	Transportation Accident (Helicopter)	Diesel	No deaths
29 Sep. 2000	Shanxi, China	5.2 tones of sodium cyanide spilled into Shuangjiang river from a truck	Cyanide	No deaths
11 Oct. 2000	Inez, Kentucky, USA	Tailings dam failure from collapse of an underground mine beneath the slurry impoundment	coal waste slurry	No deaths
11 Oct. 2000	Chengdu, Sichuan, China	Phosphate mine rock slide	N/A	More than 20 deaths
18 Oct. 2000	Nandan county, Guangxi, China	Tailings dam at copper mine collapsed and buried over 100 households	N/A	At least 29 deaths, 100 missing; more than 100 houses destroyed
1 Nov. 2000	Nanchang (Jiangxi province), China	Fire broke out in a mine	N/A	13 deaths

Note: Conventional mining accidents like gas explosions and tunnel collapses have been reported but are not listed here. These accidents have accounted for some 200 deaths.

for which no one is currently accountable for site remediation or rehabilitation.

Although neither the problems of abandoned mine sites nor the solutions are simple, UNEP as well as some jurisdictions have started to address this issue which has been ignored for too long.

Conclusion

A word of caution seems needed. It should not be assumed that the problems described exist at every mine site in the world. The environmental impacts caused by mining a particular mineral are determined by the characteristics of the site, the amount of material moved, the depth of the deposit, the chemical composition of the ore and surrounding rocks, the nature of the process used to extract the mineral from the ore and the degree of stewardship practised. Furthermore, many modern mines are equipped with the technology to prevent or attenuate their impacts. The "take-home message" here is therefore that mining operations have the potential to seriously impact the environment at every stage of the process, and that there is a corresponding need for appropriate forms of control at every stage.

Notes

[1] Bioaccumulation is the net accumulation of a substance, including heavy metals, by an organism (fish to carnivores to humans) as a result of uptake from all routes of exposure (ingestion, adsorption, inhalation).

◆◆◆◆◆

Who's who in mining / environment

Many international, regional and national entities now include environmental considerations in activities related to mining. Within the UN system, UNEP (www.uneptie.org) has a particular role to play in providing guidance, information and policy advice on sustainability issues in mining and minerals development. UNEP works together with international and national partners to define "good practice" procedures and "responsible enterpreneurship" by mining companies. UNEP generally works in partnership with international and national bodies, industry, and community organizations to define a broader consensus approach to environmental management.

Development-oriented agencies concerned with mining also pursue environmental initiatives. The World Bank (www. worldbank.org) has sponsored a series of workshops aimed at defining environmental and social policies and procedures relevant to mining development. During 1998 and 1999 conferences on small scale and artisanal mining were held in Bolivia, Chile, Peru, Ecuador and Papua New Guinea. The United Nations Conference on Trade and Development (UNCTAD – www.unctad.org) has sponsored meetings and information of use to national agencies. In addition, UNCTAD, with financial assistance from the Government of the Netherlands, established the Mineral Resources Forum website (MRF). The UNEP Division of Technology, Industry and Economics (DTIE) is a principal partner in the Environment Section of MRF (www.natural-resources.org/ environment).

The United Nations Industrial Development Organization (UNIDO – www.unido.org) included small-scale mining and mercury pollution among its high-priority programmes to the year 2000, as well as providing expertise in minerals processing technologies.

The World Health Organization (WHO – www.who.int), which is concerned about health and safety impacts of mine waste, has worked with UNEP to develop information and training materials. Ongoing activities including the Sectoral

Activities Programme in the Industrial Activities Branch of the International Labour Organization (ILO, www.ilo.org) are aimed at ensuring safe working conditions at mine sites. While the United Nations Development Programme (UNDP) has no mining programme as such, its national offices frequently sponsor training, information and environmental assessment activities related to mining development.

The Baia Mare tailings accident (30 January 2000) resulted in a number of commissions being formed to consider follow up actions. These include the European Union (EU) Baia Mare Task Force, Romanian Government, UNEP and the Office for the Co-ordination of Humanitarian Affairs (OCHA) Assessment Mission, and the US Environmental Protection Agency (EPA). The objective of these investigations is to establish the cause of the accident, assess the damage, propose actions to remedy the negative impacts, propose actions to keep the general public fully informed, and to propose actions to prevent future accidents. In addition, UNIDO has begun a project in Hungary on Emergency Preparedness and Responses in Mining and Metallurgical industries. This initiative, which involves UNEP and the Government of Hungary, will look at application of the UNEP APELL (Awareness and Preparedness for Emergencies at Local Level) process in Hungary, especially along the Tisza River.

Since implementing new policies and approaches requires new skills based on up-to-date information, building such capacity in government and industry partners around the world has been an important activity for UNEP. In October 1999, the Chamber of Minerals and Energy of Western Australia and UNEP jointly organized an international conference on environmental education in the minerals and energy industries in Australia. Academics, industry and government officials discussed how environmental issues can be better incorporated into current and future teaching curricula without detracting from the extensive technical education that is required.

The United Nations Department of Economic and Social Affairs (UN DESA) and UNEP jointly held a second Berlin Roundtable on Mining and the Environment in 1999, in collaboration with the Deutsche Stiftung für internationale Entwicklung (DSE – German Foundation for International Development). (The Berlin II Guidelines are reproduced in other parts of this publication).

The Australian Government and UNEP co-hosted an international regulators workshop in Environmental Safety in Mining in Perth in October 2000, to discuss how to refine their legislative tools (discussion papers are posted on the MRF website).

At the regional level, the North American Commission for Environmental Cooperation (CEC – www.cec.org) was created in 1993 by Canada, Mexico and the United States under the North American Agreement in Environmental Cooperation to address regional environmental concerns, prevent potential trade and environmental conflicts, and to promote the effective enforcement of environmental law. Related to minerals and metals are its initiatives on sound management of chemicals and the North American Pollutant Release and Transfer Register.

In the late 1990's, the Mining Policy Research Initiative (MPRI – www.idrc.ca/mpri) was launched to address some of the concerns raised from the rapid expansion of mineral exploration and development throughout Latin America and the Caribbean (LAC). Based in Montevideo, Uruguay, MPRI focuses on the impact of mining on ecosystems and human health and the regulation of mining for environmental purposes. Appropriate research is underway to ensure that mining is supportive of sustainable development in LAC.

Industry groups are mostly organized around national mining associations and international commodity organizations primarily concerned with trade issues. One group focusing on environmental issues is the International Council on Metals and the Environment (ICME – www.icme.com) based in Ottawa, Canada. ICME has worked with many of the above organizations, especially UNEP, to review policy issues and define practical procedures for improving the industry's general environmental performance. In May 2000, ICME and UNEP jointly organized an international meeting to start the process of identifying the issues and considerations related to the management of cyanide in gold mining. ICME and UNEP also held an international workshop on emergency preparedness and response in the mining industry to discuss the application of APELL (Awareness and Preparedness for Emergencies at Local Level) to installations and hazardous materials transport in the mining sector. In addition, UNEP is drafting an APELL for the mining industry handbook. A best practice case study book on water management at mine sites, a joint UNEP/ICME publication, is also in process.

Although not primarily focused on mining, the World Business Council on Sustainable Development (WBCSD) has been promoting more systematic and integrated environmental management (eco-efficiency) by companies. One specific initiative is the MMSD (Mining, Minerals and Sustainable Development – www.iied.org/mmsd) as one of a number of projects being supported by the Global Mining Initiative (GMI – www.globalmining.com). GMI is a bold initiative of more than 25 CEO's of major mining companies to "ensure that the mining, minerals and metals industry is responsive to global needs and challenges."

Another organization making a strong contribution to the mining and environmental discussion is the International Commission on Large Dams (ICOLD), which has sponsored numerous technical publications and conferences concerning tailings dams. ICOLD and UNEP jointly published a 1996 survey of tailings incidents. A second publication entitled "Tailings Dams: Risk of Dangerous Occurrences – Lessons learnt from practical experiences" is expected to be published in early 2001. Finally, and based on recommendations in the UNEP/OCHA Baia Mare Assessment Mission Report, a study of contingency options including structures for tailings dams incorporating fail-safe features, secondary security measures, and revised siting criteria, especially when hazardous materials like cyanide are involved, is under consideration.

A number of national mining associations are increasingly addressing the environmental agenda in a pro-active way. As well as organizing regular workshops and seminars on environmental matters, several associations have developed firm policies on environmental responsibility that members are expected to abide by. A number of institutions of mining and metallurgy hold regular conferences and publish information on environmental issues, generally with a technical orientation.

Academic and research institutes mainly have a national focus. One exception is MERN – Mining and Energy Research Network (formally the Mining Environmental Research Network) which is located within the Corporate Citizenship Unit at the University of Warwick Business School (UK). Its research and training activities relate to the social, economic and environmental dimensions of sustainable development across the minerals and energy sectors. The Southern African Development Community (SADC) Mining Unit in Lusaka, Zambia, has a small environmental unit which undertakes studies and seminars in Southern Africa. A Southern Africa Workshop on Sustainable Development and the Mining and Metal Industries was held in November 2000 in Pretoria, South Africa co-hosted by SADC, the Namibian Geological Survey, the South African Department of Minerals and Energy, the Chamber of Mines of South Africa, ICME and the World Bank.

In addition, a number of national institutions are strongly focused on international work. CENTEK in Sweden, and Queens University in Canada, have programmes for international training. Many national institutes also undertake consultancy and advisory work in other countries. The Colorado School of Mines co-published a book entitled the "Sustainable Development and the Future of Mineral Investment" as a collaborative effort of the Institute for Global Resources Policy and Management at Colorado School of Mines (USA), the Metal Mining Agency of Japan and UNEP.

A few community groups are active in regard to mining and environment, often publishing information on recent problems and upcoming issues. These groups include World Wide Fund For Nature (WWF), The World Conservation Union-IUCN, Friends of the Earth, Conservation International, Mineral Policy Centre as well as a number of more nationally focused bodies in specific countries (eg. MiningWatch Canada). Key issues relate to indigenous issues, biodiversity, small-scale and artisanal mining.

Finally, many regional development banks and bilateral aid agencies in Europe, North America, Japan and Australia have sponsored environmental programmes in developing countries. These programmes typically involve a range of training, technical and assessment projects. ◆

The global mining industry

Chris Hinde, Editorial Director, The Mining Journal Ltd, 60 Worship Street, London EC2A 2HD

Abstract
It is estimated that there are over 10,000 mining and metals companies in the world, and some 20,000 mines, processing plants and smelters. In addition, there are a host of associated organizations, including learned societies, educational establishments, service companies and manufacturers. All are driven, directly or indirectly, by the orientation and success of the extractive companies, and this paper focuses on the changes being experienced by that sector of the industry.

Résumé
On estime qu'il y a dans le monde plus de 10 000 entreprises d'exploitation minière et de production de métaux et quelque 20 000 mines, usines de transformation et fonderies. Il existe en outre une multitude d'organisations associées, notamment des sociétés savantes, des établissements d'enseignement, des sociétés de services et des fabricants. Tous sont tributaires, directement ou indirectement, des orientations et de la prospérité des entreprises d'exploitation minière. Cet article se penche sur les mutations qui bouleversent actuellement ce secteur de l'industrie.

Resumen
Se estima que existen más de 10.000 compañías mineras y metalíferas en el mundo y más de 20.000 sitios mineros, plantas procesadoras y fundidoras. Además, existe una cantidad de organizaciones asociadas, incluyendo sociedades, establecimientos educativos y compañías de servicios y fabricantes. Todas se hallan directa o indirectamente impulsadas por la orientación y el éxito de las compañías extractoras y este papel se concentra en los cambios experimentados por el sector de la industria.

1. Influences on mining

From the outset it is important to be reminded that mining is different from any other industry. Unlike manufacturing industries, for example, we can not choose to mine near our market places and, unlike other primary industries, which can fertilize or restock, we cannot influence the prime sites for extraction. Moreover, because minerals are formed at a rather slower rate than maize, our operating units are always wasting concerns.

Environmental demands

In addition, the mining industry has borne the brunt of the increased public awareness of the need to protect the environment. The industry, as a whole, has been unable to alter the perception of it as a despoiler and polluter. In the developed countries in particular, this has manifested itself as greater difficulty in obtaining planning permission for new mine developments and more onerous operating constraints.

With these restrictions, and given the period over which we have been extracting minerals, it is inevitable that the search has extended to more hostile geographical environments (in terms of both location and ore grades). This combination has obliged mining companies to take on a civil engineering role as they find themselves having increasingly to construct the necessary infrastructure before mining can commence.

An excellent example of this was reported in *Mining Journal* in September 2000. The Batu Hijau mine on the remote Indonesian Island of Sumbawa marks Newmont Mining's return to the copper business after a ten year hiatus. The US$1.83 billion development is believed to be the largest greenfield mining project ever constructed. Mine production should average 600,000 tonnes per day over a life of 15 years to extract the 10,000 million pounds of copper and almost 12 million ounces of gold. It is not, however, these extraction facts that are noteworthy in the context of this paper.

Newmont, and its army of advisers (led by Fluor Daniel), have had to construct roads, port facilities, housing, a health clinic, police station, childcare centres, new water system and a 120 megawatt coal-fired power plant. The indigenous population numbered less than 9,000 but, during the construction phase. 14,000 people had to be fed and accommodated. Moreover, 600 apprentices were trained in prime crafts, 3,000 people were trained in basic construction and 7,000 craftsmen were certified.

1.1 External forces

Historical environment

In one word – "Baggage".

Few industries come with as much historical baggage as mining, and most of it is an adverse influence on politicians and investors. The image, strong still in Europe, of cloth-capped coal miners toiling away underground does precious little for the modern mining executive trying to eke out funds for new developments. Worse still, in terms of public sentiment, are the reoccurring pictures of derelict mines, ravaged landscapes and leaking dumps.

Growth in Green influence

These images resulted in the mining industry becoming one of the main targets of the burgeoning environmental movement of the 1990s. Although individual companies have striven, at the local level, to respond to these concerns, little has been done to alter public perceptions.

Whilst miners themselves still enjoy considerable public sympathy, mining (with very few exceptions) does not enjoy widespread support – and where public opinion wanders, politicians will be close behind.

Political environment

In one word "Inertia".

Because of this historical baggage and, more recently, the increased awareness of the environment, mining is unpopular. The industry does have an important role, of course, particularly in the ongoing debate about sustainable development, but (at both the corporate and industry levels) it is failing to guide the agenda.

Industry response

More concerted efforts are now being made to improve the mining industry's response to these environmental issues. For example, in October 2000, 27 companies established the 'Global Mining Initiative' (GMI) in an attempt to change the climate of antagonism. GMI will seek to respond more positively to the various issues facing the industry. Along with GMI, a major analytical study of mining has been initiated – 'Mining, Minerals and Sustainable Development'. MMSD will be an independent analysis of the key issues, and identify those things which merit action and set out the paths towards achieving them. The industry's chief executives also have relatively little political influence. Although our trucks and shovels are large, the leading companies are not. Standard & Poor's weighting for metals mining in its 500 index is under 0.6 per cent, which is less than that of the Walt Disney group alone.

In its annual 'Who Owns Who' survey (published by Roskill of London), Sweden's Raw Materials Group (RMG), lists the top ten mining companies as:

Mined Output	(% of total value)
Anglo American	7.1
Rio Tinto	4.9
CVRD	3.2
BHP	3.2
Norilsk	2.2
Codelco	2.0
Freeport McMoran	1.8
Phelps Dodge	1.7
Noranda	1.6
Grupo Mexico	1.5

The combined market capitalization of these ten companies is currently under US$80 billion. Indeed, even if we include companies which derive much of their value from processed metal and fabrication (such as the aluminium producers), the combined market capitalization of the twenty largest 'mining' companies is only about US$166 billion. By comparison, BPAmoco and Exxon Mobil have a combined market capitalization of US$520 billion.

As a result, mergers and acquisitions in the mining industry (see later) are also dwarfed by the deals in other sectors. The largest deals in the mining industry during the past five years were Alcan's US$4.7 billion takeover of algroup, Alcoa's US$4.6 billion offer for Reynolds and Rio Tinto's US$4.0 billion takeover of CRA. In contrast, this year's America Online merger with Time Warner was valued at US$182 billion, Glaxo Wellcome and SmithKline Beecham are merging to create a US$78 billion deal, and France Telecom bought Orange for US$46 billion. According to RMG, the total volume of global mergers and acquisitions last year amounted to US$304 trillion, with the mining industry reaching barely US$19 billion (0.6 per cent).

In terms of metal sales, the two largest companies in North America are Alcoa and Alcan, with revenue in 1999 of US$12.6 billion and US$6.7 billion, respectively. Leading 'mining' companies in North America include Inco (in 16th place last year with metal sales of US$2.1 billion), Freeport-McMoRan Copper & Gold (20th; US$1.9 billion), Phelps Dodge (22nd; US$1.8 billion), and Barrick Gold and Newmont Mining (26th and 27th on about US$1.4 billion each). In contrast, BPAmoco alone had revenue of US$100 billion in 1999.

Taken globally, the sales of coal (whose annual mined production has averaged a value of some US$110 billion in recent years), gold, bauxite and copper (an average of around US$20 billion each for run-of-mine output), and iron ore (US$15 billion) dominate, followed by zinc and diamonds (US$6 billion each). The total value of annual mined output is probably less than US$300 billion (with operating costs accounting for some two-thirds of this amount, the construction of new mines over US$50 billion each year and US$3-5 billion being spent on annual exploration). For comparison, the annual value of oil output is currently US$800 billion (73 million barrels per day at US$30 /barrel).

Not surprising, taken from a global perspective, mining has relatively little influence on politicians, particularly those in developed countries.

Business environment

In one word – "Capitalism".

From a European perspective, if the second half of the 18th century was characterized by the Industrial Revolution and the 19th century by the Age of Empire, then that of the second half of the 20th century was the rise, and ultimate dominance, of capitalism. Notwithstanding a recent retreat from the trenchant views of Reagan and Thatcher, we enter the 21st century with private enterprise firmly established as the modus operandi of business. (Businesses now have considerably more empathy with social and environmental issues).

In the last 50 years of the 20th century, the annual growth rate for developed countries (representing 20 per cent of the world's population) has grown by an annual average of 2.7 per cent (compared with a disappointing 2.5 per cent annual average for the developing countries), and real GDP per capita has risen by 3.1 per cent.

Governments in most developed countries have accepted the long-term benefits of restricting themselves to ensuring that there is a suitable environment for business, rather than hands-on involvement. Accordingly, most of the huge public corporations of the mid-20th century have been dismantled, and private companies have moved in and bought the profitable portions. Whilst causing considerable distress at the local level because of the inevitable redundancies, this has at least ensured that market forces can be brought to bear. (This has been particularly sharply felt in the UK, where the coal industry has declined from over 1,000 underground mines in 1947, employing one million people to produce 186 million tonnes per year, to 17 mines employing 12,000 people to produce less than 37 Mt last year).

More recently, developing country governments have taken up the initiative, and the privatization of state-owned companies in South America and Asia during the past few years has provided opportunities for diversification amongst mining companies. A good recent example came in September 2000 from India, when the government announced that it was seeking a private-sector partner to run the ailing Hindustan Copper. The proposed disinvestment will give an opportunity for foreigners to get a foothold in India, where demand for copper is expected to continue rising at over 10 per cent annually thanks to the rapid growth of the local telecommunications and electronics industries (the timing is also auspicious because of the rising copper price).

Following the widespread collapse of communist ideology in the late 1980s, mining companies have also been presented with a much wider choice of countries in which they can invest. Many of these countries host highly prospective geological environments; attractive, in part, because hitherto unacceptable investment conditions have prevented intensive exploration and development. Moreover, environmental restrictions are generally less onerous in these developing countries.

There are mighty forces driving globalization but they are not impervious to public opinion. For example, this opinion has shaped the response to concern over the environment and, as *The Economist* noted in September, governments and their international agencies have been rocked by the anti-capitalist protests held in Seattle in 1999, and in other financial centres sporadically since.

Meanwhile, any barriers to international free trade will serve to strengthen the trading blocs. It is not difficult to envisage the emergence of five strong trading blocs: the European Union, North American Free Trade Agreement, Southern Common Market (Mercosur), Southern African Development Community and the Association of Southeast Asian Nations.

1.2 Internal forces

Market place

In two words – "Supply and Demand".

The supply and demand of metals and minerals clearly has elements of both cause and effect. Changes (actual or perceived) in this market balance will alter prices, which will have an impact on the decision-making of mining companies. Such decisions will, in turn, effect the supply/demand balance.

Looking at overall demand, the general outlook for consumption of many metals, and thus their ores and concentrates, is widely held to be excellent because of the robust growth in most economies. Demand for aluminium, copper, magnesium and nickel, for example, is expected to grow for the foreseeable future.

The booming economy of the US has driven much of this expectation. A useful measure of anticipated US demand for metals is provided by the US Geological Survey (USGS). In its Primary Metals Industry index, which was developed in the mid-1930s, the USGS tracks the effects of the business cycle on 26 different metal processing sectors (including the steel, aluminium and copper sectors, for which the USGS also produces separate indexes).

The USGS produces two Primary Metals Industry indexes – 'coincident' and 'leading'. The 'coincident' index combines cyclical indicators of diverse economic activity (including production, shipments and employee hours worked) into one index, giving decision makers a measure of how changes in the business cycle are affecting the economic health of the industry. The 'leading' index, according to the USGS, historically gives signals "several months in advance of major changes in the 'coincident' index". The indicators used in this index are, for the most part, measures of new commitments to, or anticipation of, economic activity that can affect the metal industry in the months ahead.

The 'leading' index for the Primary Metals Industry (1977 = 100) improved slightly to 126 in July 2000, after slipping from 131 in January. Reflecting the long economic boom in the US, the

index has steadily risen from 100 at the end of 1990.

However, whilst facing an apparently healthy future, the experience of the past twenty years is not encouraging. In his series of Minerals Handbooks (published by The Mining Journal Ltd), Phillip Crowson has tracked the weighted price index for 50 commodities (coal is not included), and the real price index (1992 = 100) fell from over 200 in the late 1970s to 100 in the mid-1980s before recovering to 140 in 1988. Thereafter the index slumped to the nadir of 90 in 1993 before the gradual recovery of recent years.

Similarly, the Economist's Metals Index (1984 = 100; and adjusted to real terms by the US GDP deflator) reached 160 in the late 1980s before drifting to below 90 in 1993, recovering to 110 in the mid-1990s and drifting back below 80 before the end of last year. For example, although the price of copper has improved recently to US$2,000/t, in real terms (US GDP deflator again) it is still worth less than 40 per cent of what it was in 1970.

Research and development

Advances in technology have various influences on the mining industry. From the consumption perspective, the technological advances of the past few decades are altering the demand for many metals. For example, the burgeoning computer and high-tec industries are benefiting some exotic metals, such as indium and tantalum (lap-top computers and mobile telephones), and cadmium (batteries). Superimposed onto this changing demand balance is the effect of substitution and reduced unit consumption as fabrication processes become more efficient.

From the perspective of supplying metals and minerals, mining companies are benefiting from more efficient exploration procedures and extraction equipment. Both developments tend to drive down the number of jobs in the industry, while increasing the skill levels required.

Investment climate

This influence centres on the 'Professional' investor.

In the second half of the 18th century, the Industrial Revolution in England was led by coal and iron ore mining. In the subsequent 150 years, whole industries and countries were influenced and conquered by the business acumen and imagination of handfuls of entrepreneurs and adventurers. The early pages of *Mining Journal*, barely 150 years ago, were filled with scarcely believable tales of private financing and risk-taking endeavours. Notwithstanding a few gold-mining enthusiasts, this is hardly the picture of the mining industry as we enter the 21st century.

With ageing populations and tighter markets, pension and investment funds have assumed increased importance during the past few decades, leading to a concentration of company ownership in fewer hands. In the past 40 years in the UK, for example, shareholding by individuals has fallen from over 50 per cent to under 20 per cent, with pension and insurance companies now holding a combined 50 per cent of UK shares.

To make matters even worse, consolidation in the finance sector (for example the proposed merger of JP Morgan and Chase Manhattan) is expected to lead to more banks severing their ties with metal trading as commodities become more marginal to businesses dominated by investment banking.

Partly because of these influences, the share prices of mining companies have not tracked the price of metals that they produce as closely as hitherto. Thus far, the 21st century has been generally kind to metal prices. For example, the US dollar price of copper has risen by almost 12 per cent, nickel by over 7 per cent and aluminium by 3 per cent (admittedly the gold price is currently some US$10/oz, 3 per cent, below where it started the millennium). However, HSBC's Global Mining share price index (100 at end 1988) is currently only 111, having been 140 at the end of 1999. Individual disappointments include Rio Tinto (whose market capitalization, in sterling, is down 33 per cent this year), Aloca, Alcan and Anglo American (all of whose market values are down by over 20 per cent) and BHP (down 8 per cent in the weak Australian dollar). Although takeover activity has affected all of these shares, the trend is axiomatic.

Communication

Superimposed onto all of the influences mentioned above is the invigorating presence of the Internet (and, in particular, the World-Wide Web). By allowing for a dramatic improvement in all levels of communication, the Internet will redraw business and trade boundaries.

The Internet was 'born' less than 20 years ago, and e-commerce is only credited with having started challenging the 'traditional' ways of doing business four years ago. However, the world-wide e-commerce trade is now estimated at over US$50 billion, and growing fast.

From a business perspective, we can already see improvements in the dissemination of news, the procurement of equipment and services, and in the trading of commodities. Even at this early stage in Internet development, the ubiquitous e-mail dominates personal communication (and, because of its very immediacy, is the bane of many an editor).

With ever faster communication, instant news and price tracking will become mundane. Corporate intranets will ensure that relevant external developments are circulated immediately to members of staff. With the low barriers to entry, websites, like the mining companies of the 19th and 20th centuries, will proliferate. Eventually, only those sites which offer added value to the user (such as rationalization and valuable analysis) will survive.

This improved communication can be expected to benefit developing countries by providing inexpensive links to the industrialized countries of the world. Better communication should lead to improved corporate control and understanding of regional issues. With time, country risk profiles can be expected to flatten.

2. Corporate response

Although each mining company is unique, chief executives everywhere are seeking to remain (or, perhaps, to become) competitive on a sustainable basis. As business analyst Mark Payne noted in his 'Strategies of International Mining Companies' report (published by Mining Journal Books Ltd), "The conjuring trick to be performed is, essentially, to generate sustainable and acceptable long-term profits in a business where margins per tonne of ore mined and processed can be notoriously slender".

Mining companies the world over are engaged in a number of strategic initiatives intended to fulfill a variety of corporate objectives – chief amongst which are (Mark Payne again) "to increase shareholder value, to minimize the break-even point at which company operations are profitable, and to maintain corporate viability for the foreseeable future".

Efficiency drive

Seemingly as never before, mining companies are concerned to bear down on overheads, to take cost out of the production process. The implication of this imperative is a requirement for bigger and better facilities. This, in turn, creates an imperative for rationalization, integration and capital investment. There is also a focus on the introduction of new, or improved, technologies, the drive for which comes from environmental considerations, from the need to reduce operating costs, or to enable the production of metals and/or alloys which offer customers enhanced physical properties.

A good example of these changes is the iron ore industry in Australia which, faced with annual average price reductions of some 3 per cent since 1990, has been forced to ensure cost reductions through productivity improvements. The erosion of profitability has now driven a spate of consolidation, led by Rio Tinto's move in August 2000 (contested originally by Anglo American) on North Ltd. This followed the acquisition in June by the world's largest iron ore producer, Brazil's CVRD, of five mines from Samitri.

Geographical diversification

Unlike other industries, mining companies are restricted as to where they can operate by the availability of economic deposits. In this regard, mining companies are caught between the proverbial 'rock and a hard place'. The apparently investor-friendly developed countries are increasingly antagonistic towards mining companies, with politicians being swayed by public support for the environment. Until the mining industry can reverse the tide of unreasonable demands, it has become increasingly attractive to look to developing countries for the next generation of mines.

Fortunately, at about the same time as the rising tide of environmental restrictions, the end of the cold war and collapse of communism led to a wave of deregulation in hitherto centrally-planned economies, and the introduction of workable investment codes. While in the early 1980s, much of the world's mining activity was concentrated in

the Western economies (primarily the US, Canada, South Africa and Australia), within fifteen years the focus of interest had moved to South America then south-east Asia.

A survey of mining company chief executives by *Mining Journal* in last year's Emerging Markets Supplement, confirmed the interest in Latin America (with five countries in the top ten). Africa (with four top-ten candidates) did well at the expense of Asia (although Indonesia remained in ninth position despite the economic and political turmoil in that country). Not surprisingly, exploration expenditure has reflected these opinions, with 29 per cent of worldwide exploration budgets having been spent in Latin America during the second half of the 1990s.

Unfortunately, the governments of all too many developing countries still see mining operations as an opportunity for quick returns rather than a chance to secure long-term benefits for the local economy. Moreover, even countries which are sympathetic to the long-term aspirations of mining companies can suffer from serious deficiencies in infrastructure. This will deter all but a combination of the largest mining company and a highly attractive ore deposit.

The Chinese, as in most things, have a succinct way of expressing the choices open to mining companies when faced with problems in developing countries. The Chinese for 'crisis' is made up of two symbols – which can be translated as 'danger' and 'opportunity'. However, *Mining Journal*'s Emerging Markets survey noted that most chief executives remain reluctant to invest in countries with unstable political regimes or difficult business environments. In a list of 50 'emerging' countries, Russia, Tajikistan, Angola and Albania were the least popular.

The mining of gold has always mitigated country risk because of the relatively short mine lives and the ease of transporting the finished product. In its Strategic Report publication, Metals Economics Group notes that gold was the target for over half of the total exploration expenditure of some US$2.2 billion in 1999, with the next largest target, copper, attracting only half as much expenditure (US$460 million).

Expansion

The extra bureaucracy and costs associated with the trends outlined above will tend to favour larger corporations, which can better cope with the additional burdens imposed. The benefits brought about by size fall into three parts; the ability to provide central support for specialized tasks, the financial ability to make long-term commitments and the opportunity to reduce costs by undertaking tasks on a larger scale.

With regard to the first type of benefit, every mine is having to pay increased attention to environmental matters, and only the larger companies are likely to be able to afford the central support that will be required to fulfill local design and monitoring requirements. As far as the environment is concerned, such companies must seek to convince the local population that they (and the whole industry) are poachers turned gamekeepers.

Similarly, with the exception of some gold and diamond operations, most mines are long-life ventures involving the construction of considerable infrastructure (as at Batu Hijau). This inevitably requires detailed planning and careful negotiations with the local government. Neither is something to be undertaken lightly by small companies without the necessary experience. Indeed, governments of developing countries would be well advised to talk only with the larger companies. Smaller concerns are simply unable to guarantee long-term commitment and security.

There are also the classical economic advantages of scale. Cost savings can be secured by sharing job functions between a larger number of operations. However, faced with the difficulties of expanding their operations through deposit exploration and mine development, many chief executives have sought to grow their corporations by using the cheque book.

According to Metals Economics Group (MEG), nonferrous acquisition activity (of over US$25 million each) reached US$8 billion in 1999, bringing the amount spent over a ten-year period to US$56 billion – roughly half for 146 gold projects /companies and half for 135 base metals projects/companies (of which just over half were related to copper). Although the value of deals recorded by MEG in 1999 was 76 per cent above that of 1998, it was still well short of the record US$12.4 billion spent on acquisitions in 1996 (when gold prices peaked).

Sweden's Raw Materials Group (RMG) has somewhat different numbers. Quoting Ernst & Young figures, RMG puts the total volume of mining mergers and acquisitions last year at US$19.1 billion, compared with US$25.7 billion in 1998 and US$18.7 billion in 1997. This brings the total expenditure to US$110 billion since 1995. Of this amount, 30 per cent was spent on gold (US$33 billion), followed by aluminium (US$21 billion), diversified metals (US$17 billion) and copper (US$14 billion).

The top ten mining industry deals during the past five years have been:

Buyer		Target Amount (US$ billion)	Year
Alcan	Algroup	4.7	2000
Alcoa	Reynolds	4.6	1999
RTZ	CRA	4.0	1995
Alcoa	Alumax	3.8	1998
Anglo American	Minorco	3.7	1998
Inco	Voisey's Bay	3.3	1995
Consortium	CVRD	3.2	1997
Anglo American	AngloGold	3.1	1998
Newmont	Santa Fe	2.5	1997
BHP	Magma	2.4	1995

As RMG notes, it is not surprising that the aluminium sector is at the top of the merger and acquisition league because its smelters offer direct advantages of scale and the sites can be moved, unlike mines, around the world.

Because every new mining alliance prompts others to follow (if a company is not aggressively growing it might become a target itself), corporate consolidation tends to come in waves. These waves are likely to be amplified when metal prices are moving higher – as has been the case for the past year. Certainly the equilibrium of several mining sectors was disturbed by a series of mergers and restructuring during 1999.

For example, the new leadership of Australia's largest mining company, BHP, has been implementing a series of divestments (30 deals totalling A$6.9 billion since 1998). The Melbourne-based group has withdrawn from the troubled Hartley platinum operation in Zimbabwe, which was forced to close, and in the US it closed down its loss-making copper operations. In Australia, the Beenup mineral sands operation was closed, but talks with Rio Tinto with a view to merging the two companies' Pilbara iron-ore operations fell through.

In North America, the withdrawal of BHP spurred efforts to merge and consolidate amongst the big three remaining US copper producers – Phelps Dodge, Asarco and Cyprus Amax. Not all parties saw eye to eye, though, and in September 1999 a major takeover battle ensued. Matters were further complicated when Grupo Mexico entered the fray, and the result was that the Mexican company captured Asarco for US$1.2 billion, and Phelps Dodge had to be satisfied with Cyprus Amax for US$1.8 billion. Elsewhere in the copper sector, Nippon Mining and LG Metals of South Korea joined forces to become the largest copper refiner in Asia. In other sectors, Alcoa acquired Reynolds and Cordant in the US for US$4.5 billion and US$2.9 billion, respectively, and Franco-Nevada acquired Euro-Nevada for US$1.3 billion.

In Africa, Gold Fields secured control of South African gold producer Driefontein from AngloGold and minority shareholders early in 1999. Elsewhere in Africa, the protracted efforts by the Zambian Government to privatize Zambia Consolidated Copper Mines neared completion (it was finalized in April 2000) when it was announced in October that Anglo American was to acquire an 80 per cent interest in ZCCM's Konkola and Nchanga Divisions.

Also in October last year, Anglo American Corp., newly moved to London, took its first steps to establish a foothold in Australia when its AngloGold subsidiary launched a US$550 million friendly takeover of Acacia Resources, and shortly afterwards Anglo American secured a significant interest in Anaconda Nickel. Meanwhile, another partner in Anaconda, the Swiss commodities trader Glencore International, is rapidly emerging as a major participant in mining and metal projects, not only in Australia (where its acquisitions have included Cyprus Amax's coal mines) but also throughout the world, and it now rivals many major mining companies in terms of the breadth of its asset base.

Mergers and acquisitions were rife in the coal sector last year and there were also divestments. Particularly significant was the announcement by Shell in September 1999 that it was offering its coal assets for sale. The decision was in line with

similar moves already made by other major oil producers such as BP Amoco, Exxon and Atlantic Richfield to divest their coal interests and focus on their core business. Shell remains involved in the mining sector, however, and its Canadian subsidiary announced at the end of 1999 that it was going ahead with a C$3.5 billion oil sands project in Alberta.

This year's merger and acquisition activity in the mining industry (to end-September) has totalled US$17.5 billion, and has accelerated after a slow start (only US$6.0 billion was spent during the first six months, and much of that was attributed to the now cancelled merger between Goldfields and Franco-Nevada). The figures would, of course, have been significantly higher if the European Commission had not blocked the three-way merger between Alcan, Pechney and algroup. In the event, Alcan was left to acquire Switzerland's algroup.

Australia has led acquisition activity in 2000. In June, Amcoal won the auction for Shell's Australian coal interests with a bid of over US$500 million. This was followed in August by Peabody Resources putting its Australian coal mines up for sale, De Beers' bidding A$522 million for Ashton Mining, and Rio Tinto's A$3.5 billion acquisition of North Ltd (after a tussle with Anglo American). At the end of August, BHP and Mitsubishi launched a A$830 million hostile bid for Australian coal producer, QCT Resources. Other Australian companies expected to come under the acquisition spotlight are MIM Holdings for its coal assets, and Melbourne-based WMC for its nickel, copper and aluminium assets.

In September 2000, the chairman of Billiton, Brian Gilbertson, commented that the mining industry is "in an era of unparalleled consolidation". This followed the London-based company's US$1.5 billion acquisition of Alcoa's 56 per cent stake in the Worsley alumina plant in Australia, and the US$1.2 billion 'white knight' bid for copper producer Rio Algom (the latter bid now looks likely to go through following the withdrawal in early October of Noranda).

This wave of activity is not restricted to th mining industry, and the global total of all merg ers and acquisitions in 1999 was US$3,400 bi lion, after only US$2,400 billion in 1998. Th automobile industry is undergoing aa series of fa reaching amalgamations, for example Gener Motors has forged a partnership with Fia Renault has cemented its ties with Nissan, an DaimlerChrysler has agreed alliances with Mi subishi Motors and Hyundai. Similarly, the avia tion industry has been experiencing a series o amalgamations, albeit the latest venture, involv ing a merger between British Airways and KLM was recently abandoned after the two groups wer unable to agree a joint structure.

3. SummaryThere have been 11 deals wort over US$1 billion during the past 12 months bu despite this wave of activity, RMG notes that the is still a lower degree of production concentratio in the mining industry than in other industrie There is, however, considerable variation in co

Financing and sustainability

Since its creation in 1972, the United Nations Environment Programme (UNEP) has encouraged economic growth that is compatible with protection of the environment. This mandate was strengthened by world leaders at the 1992 Rio Earth Summit. One of the results of this was the creation of a new partnership between UNEP and the banking sector. From 1992 to 2000, this partnership has grown to include more than 260 signatories in 57 nations.

However, pressure remains on the environment, and all sectors need to become more proactive in ensuring environmental issues are included in decision-making. For example, in May, 2000 the Malmö Declaration from the first Global Ministerial Environment Forum called for greater commitment by the private sector.

"11. The private sector has emerged as a global actor that has a significant impact on environmental trends through its investment and technology decisions. In this regard, Governments have a crucial role in creating an enabling environment. The institutional and regulatory capacities of Governments to interact with the private sector should be pursued to engender a new culture of environmental accountability through the application of the polluter-pays principle, environmental performance indicators and reporting, and the establishment of a precautionary approach in investment and technology decisions. This approach must be linked to the development of cleaner and more resource-efficient technologies for a life cycle economy and efforts to facilitate the transfer of environmentally sound technologies."

Mineral exploration and production are financed in disparate ways by a variety of institutions. Financing may be private or public, debt, equity, or insurance. Whatever the form, those who put their funds at risk in exploration or mining ventures have an increasing number of reasons to involve themselves in the discussion about the mining industry's performance on environmental, social, and economic issues as mining initiatives offer both opportunities and risks to physical and social environments.

Financial performance of mining companies has in recent years been affected by a plethora of mining related accidents and community related problems. Governments, multilateral agencies, and civil society at large, including labour, indigenous groups, and local and international NGOs are demanding higher standards regarding environmental, social, and economic performance. Because of a few high profile incidents, some mining companies are experiencing delays in project implementation and are having difficulties recovering invested funds. Current discussions with the financial sector indicate that these issues are increasingly being noted in portfolio and reputational risk assessments[1]. Higher profile risks are influencing access to capital and shareholder value. Evidence also indicates that environmental risks at mine sites tend to be underinsured, uninsurable or self-insured.

To date, banks and insurance companies have not been sending adequate signals to poor performers on environmental and social issues. A number of questions remain to be addressed. How is a bank's environmental/sustainable development policy being translated into transactional criteria? How do banks report on environmental performance?

UNEP, the World Bank and the Mining Minerals and Sustainable Development Project are examining the role of financial institutions in sustainability in the minerals sector. International financial institutions have a greater role to play in improving the environmental performance of the mining industry. It is increasingly important to recognize that: pollution control is a cost; pollution clean-up is a monumental cost while pollution abatement, cleaner production, and accident avoidance is actually an investment.

Note

[1] In the UK, pension fund trustees must now state the extent to which environmental, ethical and social matters are considered in their investment decisions (is is affecting more than £800 billion).

centration levels between metal sectors. The highest level of concentration is in tin production, where (1998 figures) four companies control 74 per cent of western world production. The second highest level of concentration is in the nickel industry, where the largest ten companies control 81 per cent of western world production. Other levels of concentration for the largest ten companies in each sector are calculated by RMG as chromite production (80 per cent in 1998), bauxite (72 per cent), copper (70 per cent), lead (61 per cent), zinc (51 per cent) and gold (50 per cent). Every three months, Mining Journal Ltd's *World Gold Analyst* publication examines the operating and financial results from 70 of the world's leading gold producers. According to these figures, the largest 50 producers currently account for around two-thirds of the world's gold output. Restructuring of the iron ore sector during the past two years will have affected the concentration statistics. RMG gives iron ore concentration as 63 per cent for the leading ten companies in 1998 but recent analysis suggests that just three groups (Rio Tinto, BHP and CVRD) may now account for 80 per cent of iron ore production

Notwithstanding the current level of activity, RMG believes that a trend towards increased concentration which was observed in the mid-1990s has been reversed in recent years. At the end of 1999, the three largest companies only controlled 15.2 per cent of the total value of all non-fuel mineral production, compared with 17.8 per cent at the end of 1997 and 21 per cent in 1984. According to RMG figures, the ten largest mining companies accounted for 27.1 per cent of total production, compared with 34 per cent in 1984, and the share of mined production enjoyed by the largest 50 companies fell below 60 per cent last year. RMG attributes most of this decline to a fall in the relative value of copper and gold, which make up a large proportion of the controlled-production of the largest companies. It may also, of course, be related to a move towards commodity specialization, so that the leading companies are focussing on relatively few metals.

RMG concludes that this fall in production concentration in the mining industry is because of the limited synergies available to mining companies compared with other markets (where brands, market access and proprietary technologies may justify the payment of acquisition premiums). However, the Swedish consultancy believes that the trends prevailing in other industries will also reach mining, and that we can expected more and bigger mergers, and, finally, increasing concentration. Accordingly, the total number of major participants in the mining industry will decline, with sector consolidation continuing apace as the winners build critical mass, adopt 'best practice' philosophies and become 'global' corporations. The remaining companies in the sector will be providing these huge corporations with a service, whether it be the supply of new deposits to exploit, mining/processing equipment or the provision of specialist advice. ◆

Fundamental Principles for the Mining Sector (Berlin Guidelines 1991, revised 1999)

Governments, mining companies and the minerals industries should as a minimum:

1. Recognise environmental management as a high priority, notably during the licensing process and through the development and implementation of environmental management systems. These should include early and comprehensive environmental impact assessments, pollution control and other preventive and mitigative measures, monitoring and auditing activities, and emergency response procedures.

2. Recognise the importance of socio-economic impact assessments and social planning in mining operations. Social-economic impacts should be taken into account at the earliest stages of project development. Gender issues should also be considered at a policy and project level. (New principle)

3. Establish environmental accountability in industry and government at the highest management and policy-making levels.

4. Encourage employees at all levels to recognise their responsibility for environmental management and ensure that adequate resources, staff and requisite training are available to implement environmental plans.

5. Ensure the participation of and dialogue with the affected community and other directly interested parties on the environmental and social aspects of all phases of mining activities and include the full participation of women and other marginalised groups. (Revised)

6. Adopt best practices to minimise environmental degradation, notably in the absence of specific environmental regulations.

7. Adopt environmentally sound technologies in all phases of mining activities and increase the emphasis on the transfer of appropriate technologies which mitigate environmental impacts including those from small-scale mining operations.

8. Seek to provide additional funds and innovative financial arrangements to improve environmental performance of existing mining operations.

9. Adopt risk analysis and risk management in the development of regulation and in the design, operation, and decommissioning of mining activities, including the handling and disposal of hazardous mining and other wastes.

10. Reinforce the infrastructure, information systems service, training and skills in environmental management in relation to mining activities.

11. Avoid the use of such environmental regulations that act as unnecessary barriers to trade and investment.

12. Recognise the linkages between ecology, socio-cultural conditions and human health and safety, the local community and the natural environment. (Revised)

13. Evaluate and adopt, wherever appropriate, economic and administrative instruments such as tax incentive policies to encourage the reduction of pollutant emissions and the introduction of innovative technology.

14. Explore the feasibility of reciprocal agreements to reduce transboundary pollution.

15. Encourage long term mining investment by having clear environmental standards with stable and predictable environmental criteria and procedures.

Challenges to sustainable development in the mining sector

Deborah J. Shields[2], USDA Forest Service – Research and Development, Rocky Mountain Research Station, 2150A Centre Avenue, Fort Collins, CO 80526, USA. E-mail: dshields@fs.fed.gov
Slavko V. Solar, Geological Survey of Slovenia, Dimiceva 14, 1000 Ljubljana, Slovenia. E-mail: slavko.solar@geo-zs.si

Abstract
The basic principles that underpin virtually all of the definitions of sustainability are now being applied to the mineral sector; however, there are both obvious and subtle obstacles to their application. These include the principles themselves and the fact that they are in some cases at odds with the way social and economic systems currently operate. We conclude that, because there are many ways to define and implement sustainable development, applying its principles can lead to a diversity of possibilities. This does not decrease the likelihood of resolving open issues, but rather presents opportunities for balanced solutions that fit the specific conditions of each particular mineral operation or activity, as well as the unique situation in each country.

Résumé
Les principes de base qui consistent à informer tout le monde des définitions du développement durable commencent à être appliqués au secteur minier. Mais ce processus se heurte à des obstacles à la fois évidents et subtils. Notamment la nature proprement dite de ces principes et le fait qu'ils soient parfois en contradiction avec la façon dont les systèmes sociaux et économiques fonctionnent actuellement. Nous en concluons qu'en raison des multiples façons de définir et de mettre en oeuvre le développement durable, l'application de ces principes peut générer une grande diversité de possibilités. Cela ne réduira pas les chances de résoudre les questions encore en suspens, mais donnera au contraire l'occasion de trouver des solutions équilibrées, adaptées à la situation générale et spécifique de chaque site minier et à ses activités.

Resumen
Actualmente, en el sector minero se están aplicando los principios básicos que informan al público en general sobre la definición de sustentabilidad. Pero existen obstáculos tanto obvios como sutiles. Entre ellos se encuentran los principios mismos y el hecho de que los principios a veces se contraponen a la manera en que funcionan los sistemas sociales y económicos. Concluimos que como existen numerosas maneras de definir e implementar el desarrollo sustentable, aplicar sus principios puede llevar a una serie de posibilidades. Esto no reducirá la probabilidad de resolver temas pendientes, sino que presentará oportunidades para soluciones equilibradas que se adecuen a las condiciones generales y específicas de cada mina en especial y de las actividades relacionadas con ésta.

Introduction

The purpose of mining is the extraction and processing of energy and mineral resources. Use of these resources is fundamental to human well-being as they are essential to virtually every sector of the economy, are the basis for the human-built environment, and provide desired services. Not surprisingly, demand for energy and minerals increases as economies expand and global population grows (hereafter the term minerals will serve as a proxy for nonrenewable resources in general).

However, these resources have intrinsic characteristics that make them not only useful, but also problematic. First, they, or their constituent elements or compounds, may be durable. Because of this tendency to persist and in some cases bioaccumulate, the costs, as well as the benefits of energy and mineral use can extend across generations. Second, mineral deposits are frequently unique (in their occurrence and nature) or are of lower or higher quality in terms of grade or volume. As a result, the siting of mineral operations depends upon the location and character of deposits. They may be in an area where mining is not a preferred land use, e.g., adjacent to or beneath an existing community or in an environmentally sensitive area. Moreover, only those extraction and beneficiation methods appropriate to the characteristics of the deposit can be employed, and in some cases those methods may entail relatively greater short- or long-term environmental risk.

Awareness of global interdependence, especially with regard to resource scarcity and anthropogenic impacts on earth's carrying capacity, has led to a more complex and comprehensive view of human activity. Thus, we have a dynamic tension between demand for minerals and demand for control or mitigation of the negative impacts of energy and mineral development, use and disposal. There is a recognized need for development with its attendant mineral resource use counterbalanced by a general consensus that such use, in terms of both types and amounts, cannot continue in present fashion.

In reality this is not an either-or situation, but rather one of fulfilling the competing objectives of optimizing contributions to economic development and societal well-being while minimizing social and environmental degradation. Sustainable development (SD), which has emerged as the prevailing paradigm for balancing society's environmental, social, and economic goals, offers a framework within which the appropriate combination of consumption and preservation can be sought.

Sustainable development is: a concept of needs, an idea of limitations, a future oriented paradigm, and a dynamic process of change. There are many alternative definitions of SD, each reflecting a different political or philosophical perspective. The mainstream definition from the Brundtland Commission report proposes "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The IUCN, WWF, and UNEP describe SD as "improving the quality of human life while living within the carrying capacity of supporting ecosystems." This lack of agreement notwithstanding, a set of basic principles underpins virtually all definitions of SD (see Table 1).

In the past decade there have been many conferences, projects, reports, actions, etc. at which the various aspects of first defining and then implementing SD principles in the mineral sector have been addressed (see Table 2). There are, however, both obvious and subtle obstacles to doing so. One is the set of principles themselves. Some are inherently in conflict with each other because they reflect different perspectives on the meaning or goals of sustainability. A second is the effectiveness of the various alternative approaches to implementing SD principles. Finally, there is the fact that the principles of SD, and the goals they espouse, are in some cases at odds with the way social and economic systems currently operate.

SD concepts and their application in mining

SD is often described in terms of capital, or the related terms endowments and wealth. The types of capital are: natural capital (traditional natural

resources), human-made capital (physical, produced assets and the built environment), human capital (the health and well being of individuals), and social capital (the complex of social relations, norms and institutions). The capital theory approach is particularly appropriate for minerals because nonrenewable natural resources are part of natural capital. They also represent a form of endowed wealth for societies. The transition from natural capital to human-made, and further to human and social capital, can be described as moving from primary means to ultimate ends, i.e. well-being.

Weak sustainability is distinguished from strong in terms of capital maintenance and augmentation, i.e. by the degree to which alternative types of capital are deemed substitutable for one another. Weak sustainability preserves the net amount of capital, but not necessarily each of the four kinds of capital, so different types of capital are viewed as substitutable. Strong sustainability requires that each type of capital be preserved independently; different types of capital can be complements to, but not substitutes for, one another.

Pure strong sustainability would ban all extraction because doing so would reduce the fund of natural capital available for future generations (who would in turn be precluded from extraction). Pure weak sustainability is equally untenable. There are life-support, aesthetic, and spiritual services provided by nature for which there are no substitutes. Sensible sustainability falls somewhere between these two extremes and offers an intermediate path to "more" sustainable patterns of behaviour.

From the capital theory perspective, SD can be thought of as the process by which societies transform economic, environmental, and social capital in ways that yield constant or increasing opportunities for satisfying human needs and wants, generation after generation (weak SD). Alternatively, SD can be viewed as development that leaves at least the same amount of capital (natural, man-made, human, and social) to future generations as that to which current generations have access (strong SD). As will be noted in later sections of this article, obstacles to applying SD to minerals activities often stem from differences of opinion about the relative validity of weak versus strong sustainability.

Table 1
Sustainable development principles relevant to mineral resources and mining

Basic SD Principles
- Human Needs Paramount / Satisfaction of basic human needs
- Integration of Environment and Development
- Inter-generational Equity / and Justice
- Intra-generational Equity / and Justice

Environmental SD Principles
- Keep within the Earth's Carrying Capacity
- Non-exhaustion of Natural Resources
- Minimize the Depletion of Non-renewable Resources
- The Precautionary Principle
- The Polluter-Pays Principle
- Eco-efficiency
- Full-costing
- Environmental Impact Assessment and Management

Socio-political SD Principles
- Public Participation in Governance / Cooperation
- Multi-stakeholder Approach / Partnership
- Communication and Education
- Consensus Building Process
- Increased Regulation
- Institutional Capacity
- Democratic Self-determination
- Sovereignty over Resources

Examples of conflicting principles

Principle 21 of the 1972 Stockholm Conference declared that States have a sovereign right to exploit their own resources pursuant to their own environmental policies. Rio Declaration Principle 2 repeated that Principle, adding a responsibility to prevent trans-boundary environmental damage. Rio also calls for the drafting and implementation of international and national law to promote SD. Beyond some point it will be impossible to fulfill both principles because, by joining international treaties and other agreements, States automatically surrender a portion of their sovereignty. While it is unclear which Principle will or should dominate, it is not hard to imagine circumstances under which individual countries refuse to sign or abide by international treaties for reasons of national pride or self-interest. They may then behave in ways that make the attainment of a sustainable future that much more challenging for other nations. Conversely, countries may find that, having joined free trade agreements, they are no longer able to ban the importation of mineral commodities produced under less stringent environmental regulation than their own national laws mandate. Domestic firms that incur costs by complying with regulations and by producing in an environmentally-sound manner could be put at a competitive disadvantage.

Another example of conflicting goals involves the Principle that calls for minimizing the depletion of nonrenewable resources. One way to fulfill this goal is to increase the recycling, reuse, and remanufacture of minerals. Emphasis to date has been on metals, but increasingly there are efforts to recycle construction materials as well. The ability to reuse, recycle, and remanufacture represents one of the beneficial aspects of durability. Recycling rates for lead batteries are approaching 95 per cent in some countries; recycling rates for glass and aluminium containers are also high. Trade in metals waste, scrap, and materials for recovery is thriving as countries with the facilities for and a competitive advantage in materials reprocessing purchase those materials from other parts of the world. However, an increasing number of international treaties aimed at protecting the environment and preventing the dumping of hazardous wastes (e.g., Basel Convention) have the potential to limit or even eliminate this trade. While the reduction of environmental and health risks is a worthy goal, these agreements may have unintended negative consequences. For example, if materials with metal content cannot be exported, they will have to be disposed of in-country. This outcome is not without its own set of risks. In countries where environmental controls are weak or where appropriate reprocessing facilities are not present, materials may be discarded without regard to the potential for negative environmental or human-health impacts.

The foregoing is an example of the type of unintended complications that might follow the premature or ill-considered application of the precautionary principle. Such situations could arise if policy makers or Intergovernmental Organizations (IGO's) were to utilize the strong definition of sustainability as opposed to the more moderate definition of sensible sustainability. Uncertainty, unknowability and unpredictability are inherent aspects of SD, given that our scientific understanding of the environment is incomplete. Making decisions while ignoring uncertainty will inevitably lead to a continual series of surprises, failures, and environmental disasters. But good public policy is the product of a prudent combination of open debate (scientific and political), caution, and a regulatory system that is capable of self-correction. The world is not lacking in debate, and the precautionary principle was adopted in response to concerns that necessary regulation had too often been delayed in the face of uncertainty. The open question is whether the resulting body of international and national law and policy will be revised as we gain more understanding of natural systems. Scientific inquiry is self-correcting over time; for SD to be successful, policy and law will need to be correctable and adaptable as well.

Difficulties in operationalizing SD

One of the major trends in recent years has been the institutionalization of SD principles through: 1) reorganization and restructuring of IGO's to address SD issues, 2) development of international and national policies and laws that reflect SD principles, and 3) voluntary or compulsory adoption of SD-oriented standards of corporate behaviour. Hence, three paths for operationalizing the SD paradigm have emerged: the admonitory, the legal, and the business practices approaches. We will focus here on the second, which is essential to the implementation of SD, but which can never be totally effective in the absence of coordination with the other two approaches and cooperation among stakeholders.

The legal path may derive from international treaties, or may be initiated through national legislation. As noted above, treaties reduce the sovereign power of nations. Increased nationalism may lead to the rejection of international treaties on environmental protection or trade that are perceived to unduly restrict a country's freedom of action.

At the national level, reform of national mining policies and laws is one way to institutionalize SD principles; however, this activity is not in and of

Table 2
Selected recent examples of activities addressing sustainable development issues in the mining sector

Examples of International Organization Activities:

Berlin Roundtable (I and II) on Mining and the Environment, 1991 and 1999
Organizers: UNEP and UNDESA
Purpose: To develop environmental guidelines for mining operations

International Copper, and Lead/Zinc Study Groups, Workshop on Sustainable Development, 1999-ongoing
Organizers: governments of mining producing nations
Purpose: To discuss cross-sectoral social, economic and environmental issues related to the sustainable development of non-ferrous metals and determine how non-ferrous metals foster sustainable development.

Sustainable Mineral Resource Management in Karst Areas – NATO workshop, 2000
Organizers: U.S. Forest Service & Geological Survey of Slovenia
Purpose: To review the state of science with respect to the social, economic, environmental and geophysical aspect of extraction in karst and to determine whether the existing science is adequate to support sustainable resource management.

Examples of National Activities:

Sustainable Minerals Roundtable, 1999-ongoing
Organizers: U.S. Forest Service and U.S. Geological Survey
Purpose: To develop national-scale, consensus set of indicators of sustainability for energy and mineral material systems

Indicators of Sustainable Develop of Minerals and Metals, 1999-ongoing
Organizer: Natural Resources Canada
Purpose: To develop consensus set of indicators of sustainability for minerals

Examples of NGO and Industry Association Activities:

Lima Workshop on Mining and Sustainable Development in the Americas, 1998
Organizers: International Institute for Sustainable Development and International Development Research Centre, Canada
Purpose: To improve mining policies and practices to ensure that mining activity contributes to the achievement of sustainable development in the hemisphere.

Mining Minerals and Sustainable Development Project (MMSD), 1999-ongoing
Organizer: International Institute of Environment and Development, with funding from industry
Purpose: To identify how mining and minerals can best contribute to the global transition to sustainable development.

Sustainable Development: What does it mean to the Mining Industry, 2000
Organizer: National Mining Association, USA
Purpose: To introduce mining industry representatives and others attending the MINExpo to the concept of minerals in sustainable development and to discuss related activities ongoing domestically and internationally.

Environmental & Social Performance Indicators and Sustainability Markers in Minerals Development, 1998-ongoing
Organizer: Mining and Energy Research Network – MERN, Warwick University, UK
Purpose: To manage the environmental and social effects of mineral development for the better

itself synonymous with SD. The purpose of mining law reform is typically to make the country in question a more attractive target for mineral exploration and development. Such development occurs at the intersection of policies on property rights, security of tenure, taxation, water, direct foreign investment, labour, safety, community impacts, and the environment, etc. Because of this interconnectedness among mining policy and other policies, which is the essence of SD, consistency across sectors is essential. A lack of harmonization of the legal framework will make the realization of national SD goals difficult. Unfortunately, progress on reform is sometimes slowed because of the difficulty in reaching agreement between multiple ministries and departments about what to sustain or how to do so. For example, environmental ministries tend to propose polices and promulgate regulations that reflect the precepts of strong sustainability, a stance consistent with their charge to protect the environment. On the other hand, the goals of mining policy reform, which focus more (or perhaps even exclusively) on economic development, are by their very nature consistent with a weak sustainability.

A legal structure supportive of SD goals is only meaningful if those laws are enforced. Typically, this involves the promulgation of regulations, the development of a monitoring system to determine compliance with regulations, and the imposition of consequences should laws and regulations not be followed. Not all countries have functioning institutions to carry out these tasks. In some cases, regulations are never written, in others they are not enforced, due to a lack of either the capacity or the will to do so. Moreover, the intra-generational equity principle of SD implies redistribution, but powerful vested interests may resist the implementation or enforcement of laws that would reduce their access to the profits generated by mineral production. The flow of foreign and domestic investment may be curtailed in response to such problems of governance, which could in turn limit a country's opportunities for economic growth and the reduction of social inequities.

Agenda 21 clearly states that environmental regulations should be appropriate to national culture, priorities, capacities, etc. There are, however, potential downsides to this sensitivity to national circumstance regardless of how appropriate or necessary it may be. One relates to the level of environmental protection that different developing nations choose to adopt. In the absence of assistance from developed nations, poor nations cannot afford to implement and enforce stringent environmental laws. However, if environmental protections in numerous developing nations are of limited scope, the cumulative impacts could make SD unattainable globally in the long run. Alternatively, a country might attempt to court mineral investment by limiting its environmental regulations, ostensibly due to either a lack of capacity or cultural norms, a situation which could be tempting to less responsible mining firms.

Another difficulty associated with using a legal approach to institutionalize SD is that national policies are not necessarily consistent with local goals, objectives and policies. Policies contributing to a desirable outcome at one level may result in undesirable, and perhaps unsustainable, outcomes at another. This phenomenon occurs in both directions. For example, a policy that enhances environmental sustainability at the landscape scale may make the economy of a rural community within that landscape unsustainable. Additionally, when the costs of resource development are borne locally, but the benefits are distributed nationally, local opposition to mining can be strong. Imposition of mineral developments offering national benefits without regard to local preferences is inconsistent with the principle of public participation in governance. Conversely, a development decision that enables a single community to be sustainable may have negative cumulative effects at a broader scale if made simultaneously by many communities in the same area. As has been demonstrated repeatedly, multiple locally appropriate and viable decisions do not automatically translate into sustainable national or global outcomes. Finding a balance between policies and laws that fulfill national versus local desires will be challenging.

Finally, it should be noted that mining firms obtain the necessary permits and work collaboratively with community representatives in the expectation that, having fulfilled all the legal requirements and having reached agreement with major stakeholders, they will be allowed to mine. Given the climate of opposition to mining, this is no longer the inevitable outcome. Having been unsuccessful in stopping a mineral development through legal means or negotiation, some groups opposed to mining are turning instead to the political arena. Appealing to elected officials, or turning to the court of world opinion, can be a successful strategy for halting mineral operations that have already fulfilled all the regulatory requirements. There are several potential downsides to this course of action. First, repeated incidents will inevitably decrease the willingness of firms to work collaboratively with stakeholders, thus undermining the principles of cooperation and partnership. Second, mineral operations provide jobs, income, tax revenues, and often indirect rent transfer in the form of school, road or hospital construction. Blocking the development of mines on principle may leave some remote rural areas with few other options for the alleviation of poverty.

Realities

One of the most important features of SD is that it represents not so much an end point as a process of change from relatively less to relatively more sustainable patterns of behaviour. Change will be necessary because some features of existing institutions, law and cultures are inconsistent with SD. Changing these features may well prove to be the most difficult challenge of all.

The first of these features is the manner in which markets and economies function. Neoclassical economics is based upon the principle of consumer sovereignty, with well-being defined by the satisfaction of personal preferences. This view

does not easily incorporate social vision. Moreover, there is no reason to believe that unfettered market decisions will steer society in a sustainable direction. Without clear rules of responsibility and reciprocity, maintenance and production of environmental quality and social capital can be jeopardized because it is within self interest to "free ride." The implications of this reality for the ultimate success of SD are numerous. We will consider only one.

As was noted earlier, there is general agreement that current resource consumption levels are unsustainable. There have been various proposals for lowering resource use, such as increasing resource productivity and decreasing material inputs per service. It has also been suggested that developed nations dematerialize, i.e., decrease their material use by a factor of between 4 and 10 over the next 50 years, so that developing nations can increase their consumption somewhat. The open question is how to convince people to consume less. Market mechanisms alone are unlikely to be totally effective. Policies that create disincentives will help, but the most straightforward of those, taxation, is unpopular, so many politicians will be reluctant to use that tool. The reality is that the marginal effect of one consumer's use of resources is negligible, which is an incentive to free ride, to depend upon others to reduce their consumption rather than changing one's own behaviour.

There are other market issues as well. Development, including mineral development, is a fundamental tenet of SD. Unless it is to be financed and perhaps subsidized by governments, mineral development and production must respond to the dictates of global financial, equity and commodity markets. International Financial Organizations and many private banking institutions insist that mining operations follow codes of best practice and other standards to receive loans, loan guarantees, or liability insurance. Equity markets have no such overarching policies or ethical imperatives. While there has been an increase in "green" investing, mining firms must compete for investment dollars with businesses in other sectors of the economy. The value of their share price is in part dependent upon earnings. The more costs a firm incurs as a result of environmental and other forms of legal compliance, voluntary adherence to codes of practice, and efforts at continuous performance improvement (as with ISO 14000 standards) the lower the firm's earnings, especially short term. Markets are seldom kind to firms with low earnings.

Mining firms have criteria against which they judge alternative investment opportunities. The list typically includes security of tenure, fixed environmental requirements and tax terms, and management control. The latter of these can be at odds with the concept of public participation in governance and management. There is wide agreement that interested stakeholders should participate in discussions about the nature and extent of mining operations. There is less agreement over who is a legitimate stakeholder, who is actually affected, and who should be engaged. Moreover, it is one thing to give stakeholders a voice in the debate, a seat at the negotiating table, and to seriously consider their opinions and point of view. It is something else entirely to give stakeholders an actual say in the decision, which ultimately means giving up some degree of control and power to another party. There is great ambivalence in both industry and governments about how far public participation should go.

There is also the potential for a disconnect of expectations between the mining company and the community or developing country. The reality is that – various forms of rent transfer and corporate socially responsible behaviour notwithstanding – no single mining, firm, or industry can solve all the social and economic problems of a developing country, region, or community. One challenge in extending SD to the minerals sector will be to identify those social, economic, and environmental issues that are both within the capacity of the firm (financially and logistically) to affect, and which it is within reason to expect them tackle.

The achievement of a sustainable future is predicated upon both people's right to express their opinion and their willingness to accept the responsibility for consequences of their position and their personal choices. Stakeholders have objectives for resource management and opinions about the goals of SD. They should have the right to ask mining firms how they intend to work with local communities and ameliorate the negative impacts of mineral development. Unfortunately, there is not currently an effective mechanism for communicating to stakeholders the relationship between their expressed objectives and the consequences of fulfilling those objectives. The actual outcome may be as they desire, but cause other undesirable and/or unintended environmental or social impacts. Alternatively, the outcome may be the one desired, but may have associated high costs that would be passed on to others. Or, the expected outcome might actually conflict with the stakeholder's broader fundamental or strategic objectives.

Consider for example the often significant opposition to the development of large new mineral operations in remote, pristine areas. That opposition is frequently predicated upon the assumption that in the absence of exploration and development permits, the area would remain in an undeveloped, natural state. However, this assumption is inaccurate for those areas already under pressure from illegal poachers and loggers, slash and burn agriculture, or extraction by artisanal miners. The reality is that in such cases development of the mine might actually increase the likelihood that the area could be preserved in a natural state. First, legal mining can be more easily and effectively monitored and controlled than can illegal mining. Second, the firm could help pay for guards and other protections that would act to minimize unwanted activities. And third, the jobs, income, and tax revenues generated by the mine would help to alleviate the poverty that is a source of much illegal and environmentally damaging activity. Thus, banning mineral development may have its own set of economic, social, and environmental opportunity costs for which those opposed to all mining on principle should accept some degree of responsibility.

Conclusions

The problems described above are not insurmountable, but they do present challenges to those attempting to implement sustainable development policies with respect to mining. These challenges, and others not discussed here, have many sources: a lack of understanding of the need for balance across the social, economic, and environmental dimensions; lack of capacity to implement SD; unwillingness on the part of some segments of the industry to embrace SD; entrenched opposition to mining; unrealistic requirements that lead to deadlocks over development or reclamation; endemic poverty; excessive consumption; political and civil unrest; and others too numerous to mention. Each of these is a human issue with an environmental consequence, which is another way of stating the truism that environmental problems are social problems. They are the aggregate effects of humans making choices and living their everyday lives. Playing economic development goals against environmental goals is inappropriate and ineffective because the two are interconnected and mutually dependent.

If SD is to be successful, humans will need to act cooperatively to develop solutions that can control environmental degradation associated with mining while maximizing the benefits to be derived from mineral resource use. The social dimensions of SD, i.e. openness, effective communication, and broad participation, hold great potential for facilitating such consensus based development and preservation. As we noted at the beginning of this article, there are many ways to define SD. This could be viewed as a serious obstacle to the implementation of sustainable practices. We suggest the opposite, that the many different perspectives on how to combine and weight the principles of SD provide numerous opportunities for crafting balanced solutions to the complex problems associated with mineral resources. Sustainable solutions must fall within the limits of environmental systems while simultaneously being appropriate to specific mineral activities and to the social, economic and cultural characteristics of individual countries. This will be the ultimate challenge in applying SD principles to minerals resources.

Note: Complete references for this article are available from the authors at the e-mail addresses shown at the beginning of the article.

◆

Environmental management and global reporting

The Global Reporting Initiative – an opportunity for the mining industry

Robert K Massie, Chair, GRI Steering Committee; and Executive Director of CERES
Allen White, Transition Director, GRI; and Vice President, Tellus Institute
Nancy Bennet, UNEP consultant to the Global Reporting Initiative, The Netherlands

Abstract
Business managers, investors, consumers, governments, and others are all asking versions of the same question: how do we obtain a clear picture of the human and ecological impact of business, so that we can make informed decisions about our investments, purchases, and partnerships? The Global Reporting Initiative (GRI) is a long-term, multi-stakeholder, international undertaking to develop globally applicable sustainability reporting guidelines for voluntary use by organizations reporting on the economic, environmental, and social dimensions of their activities, products and services. The GRI raises sustainability reporting to the same level of acceptance and consistency as financial reporting.

Résumé
Les chefs d'entreprises, les investisseurs, les consommateurs, les gouvernements et bien d'autres groupes posent tous la même question sous des formes différentes : comment obtenir un tableau clair de l'impact humain et écologique des activités économiques, afin de prendre des décisions éclairées en matière d'investissements, d'achats et de partenariats ? La Global Reporting Initiative (GRI) est une entreprise internationale multipartite à long terme, qui se propose d'élaborer des lignes directrices universelles que les entreprises utiliseraient à titre volontaire pour produire des rapports sur les dimensions économiques, environnementales et sociales de leurs activités, produits et services. La GRI a pour ambition d'amener les rapports sur le développement durable au même niveau d'approbation et de cohérence que les bilans financiers.

Resumen
Los administradores de empresas, los inversores, los consumidores y los gobiernos están formulando versiones de la misma pregunta: ¿cómo obtener una visión clara del impacto humano y ecológico del comercio, de manera de tomar decisiones contando con información sobre nuestras inversiones, adquisiciones y asociaciones? La Iniciativa de Información Globalizada (GRI) es un emprendimiento internacional a largo plazo, de participación múltiple, para el desarrollo de pautas de información sobre sustentabilidad aplicables globalmente para ser usadas voluntariamente por las organizaciones que reportan sobre los aspectos económicos, ambientales y sociales de sus actividades, productos y servicios. La GRI eleva el informe de sustentabilidad al mismo nivel de aceptación y coherencia que los informes financieros

"It has often been said that the resource companies missed the wave of the environmental movement in the 1970s, and have played catch-up ever since. The avalanche of non-financial reporting that is being produced is testament to the fact that the minerals industry is determined to stay ahead of the next wave."

Hugh Morgan, CEO of WMC

Accountability, responsibility, transparency and reporting are no longer just 'buzz words' in the boardrooms of many transnational corporations. These trends are spreading to attract a broad range of companies including those that are transnational, medium sized, from a wide range of industry sectors, and from all over the globe. The reasons for this are complex. They include increasing social tensions resulting from globalization, the rising public expectations of corporate behaviour, the desire to meet the needs of the world's poor, the communications revolution and the 'CNN' effect, the imperative to respect human rights, escalating environmental problems at both a global level and in our own neighbourhoods, and increasing, pressures from investors – to name but a few.

Many civil society groups and commentators, including the United Nations Secretary General Kofi Annan, point to the increasing economic power and influence exercised by large multinational companies and suggest that companies increasingly have the resources and capacity to

address these issues where governments do not. Disagreements over how to mobilize this capacity have intensified in the press, in the halls of government, in the business community, and in a variety of international forums. Representatives from business, government, and civil society are searching for new approaches to better align corporate governance with the economic, social, and environmental realities of the 21st century.

"We need help from the private sector. Transnational companies have been the first to benefit from globalization. They must take their share of the responsibility for coping with its effects."

Kofi Annan,
Secretary General of the United Nations

The mining industry is not immune to these pressures. While a mining company's products are not easily associated with the companies that produce them, the public perception of the mining industry is generally negative. In both the developed and developing worlds, many people have the perception that the mining industry is concerned only with short term profits, collaborating with unjust regimes, raping virgin territory of its natural resources, destroying native customs and biological diversity, abandoning social and physical infrastructure in remote areas once an operation is finished and leaving permanent scars in once pristine landscapes. These perceptions cannot be ignored if the mining industry is to thrive in the 21st century. These issues cause concern for many mining companies. Hugh Morgan, the CEO of WMC, referred to many of these issues in an article entitled "Sustainable development is an emerging part of our business strategy" available at http://www.wmc.com:

"The worldwide minerals and metals sector is experiencing momentous changes: commodity prices tumbling; rapid currency movements; social and economic upheavals in the developing world; and a vigorous drive for greater public accountability and voluntary public reporting. The first three issues have been analysed extensively. The fourth has occurred virtually undetected by financial markets – until a few weeks ago. One of Australia's most prestigious stockbrokers, J B Were & Son, recently (9 June 1998) issued a four-page mining research report on WMC, of which 75 per cent was about our environmental performance, specifically about our third annual Environment Progress Report. The following is an extract from the J B Were report; "The process of continuous monitoring and reporting of environmental progress is seen by J B Were as positive and necessary ... In the future, resource companies that do not respond to community standards and attitudes on environmental issues will have their growth potential severely limited." The commentary from J B Were may not be all that surprising to some, but coming from a leading stockbroker, the J B Were report is, to the best of my knowledge, a first. If there was ever any doubt that financial markets viewed environmentalism as a mainstream issue – by which I mean an issue that has the capacity to directly affect shareholder value – then J B Were has dispelled that doubt"

Collectively, the industry is working toward improving its image as well as its operations on the ground. The International Council on Metals and the Environment (ICME), an association of metals mining and smelting companies, has published a report on the changing attitudes and practices of member companies regarding community responsibilities and ethical behaviour. In addition, ICME has also recently added "community responsibility principles" to its environmental charter.[3]

From words to action:

From this maze of pressures and often-conflicting messages it is a formidable challenge for companies to address serious social and environmental issues on a day-to-day basis. Fortunately, one issue does resonate loudly and clearly. Business managers, investors, consumers, governments, and others are all asking versions of the same question: how do we obtain a clear picture of the human and ecological impact of business, so that we can make informed decisions about our investments, purchases, and partnerships? Achieving such clarity in measurement and reporting holds the promise of delivering value both to business— by providing a critical management tool—and to external stakeholders—by providing timely, relevant, and reliable information on the reporting organization.[4]

In increasing numbers, businesses around the world are choosing to voluntarily publish environmental reports – already numbering at least 2000 – detailing their management systems and environmental performance. A recent study by the Institute for Environmental Management and KPMG found that over 35 of the world's 250 largest companies are voluntarily publishing environmental reports. Of these reports, a higher level of reporting was noted in sectors with a perceived large environmental impact such as mining, pharmaceuticals, pulp and paper, chemicals & synthetics, and transport (airlines, rail, shipping)[5]. Recently, some leading companies have begun to enlarge the purview of their reporting to encompass social issues, indicating an incipient trend toward broader, environmental–social–economic sustainability reporting.

For example, an excerpt in the 'Message to Stakeholders' of the 1999 Noranda Sustainability Report reads as follows:

"In 1990, environment, safety and health were primarily about regulatory compliance, pollution and industrial hygiene. Increasingly, however, we are being called to account not only for what we do but also how we do it. Accordingly, we need to measure the extent to which our operations enhance economic development, ensure environmental protection and promote social equity".

A quick scan of the Internet demonstrates that some of the leading mining companies have issued some kind of environment report: BHP, Placer Dome, Rio Tinto, RGC, Noranda, North, and WMC have all published public environment reports, and some have also published community reports, safety reports and sustainable development reports.

"Our 1999 Environment and Community Report is part of our commitment to being open and straightforward about our successes and failures. It shows that, in a year of tough decisions and dramatic change, we continued to pursue our commitment to managing our activities in ways that integrate environmental, social and economic objectives."

Paul Anderson, Managing Director
and Chief Executive Officer, BHP

While these trends are encouraging, major obstacles remain before such reporting can reach its potential as a vehicle for higher standards of corporate accountability and before such reports can effectively be used to benchmark the performance of companies and monitor their compliance with external commitments.

One key obstacle is the absence of a generally accepted reporting framework, which would greatly enhance the credibility, comparability and comprehensiveness of corporate sustainability reports. In the same way that financial reporting standards provide users with reliable and comparable financial information a common framework for sustainability reporting is essential to elevate the practice to this level. Without such a framework, stakeholders, and companies will have limited ability to compare, benchmark, rate, and utilize performance information.

To meet this need for a common reporting framework, the United Nations Environment Programme (UNEP) has joined forces with a number of leading international organizations in the Global Reporting Initiative (GRI). Since its inception in 1997, the GRI has worked to design and build acceptance of a common framework for reporting on the linked aspects of sustainability—the economic, the environmental, and the social. Although in the long term the GRI Sustainability Reporting Guidelines are intended for all types of organizations, the GRI's initial work has focused on reporting by business organizations. The GRI recognizes that reporting on the economic, environmental, and social dimensions of organization-level activity – let alone a fully integrated sustainability assessment – is at the earliest stages of a journey that will continue for many years.[6]

The UNEP Division of Technology, Industry and Economics has for many years worked to stimulate individual companies – and industry associations through their membership – to report on their environmental performance and the implementation of their voluntary commitments in the form of codes of conduct and charters. Since 1994, UNEP and the London-based SustainAbility Ltd have produced ten reports on corporate sustainability reporting through its joint Engaging Stakeholders Programme. This programme has developed a strong reputation among a variety of stakeholders as a credible authority on corporate reporting. This programme helps meet the ever-increasing demand for corporate sustainability report benchmarking, and the further analysis of sustainability reporting at the sector-

level. UNEP's key role in GRI since its inception is a logical extension of these reporting activities.

The Global Reporting Initiative:
The GRI is a long-term, multi-stakeholder, international undertaking whose mission is to develop and disseminate globally applicable sustainability reporting guidelines for voluntary use by organizations reporting on the economic, environmental, and social dimensions of their activities, products and services. The GRI is a bold initiative that aims to elevate sustainability reporting to the same level of acceptance and consistency as financial reporting.

The GRI is convened by CERES (Coalition for Environmentally Responsible Economies), and UNEP. It also incorporates the active participation of companies, non-governmental organizations (NGOs), consultants, accountancy organizations, business associations, universities, and other stakeholders from around the world.

The GRI aims to help organizations report information in a way that:[7]

- presents a clear picture of the human and ecological impact of business, to facilitate informed decisions about investments, purchases, and partnerships;
- provides stakeholders with reliable information that is relevant to their needs and interests and that invites further stakeholder dialogue and enquiry;
- provides a management tool to help the reporting organization evaluate and continually improve its performance and progress;
- complements, not replaces, other reporting standards, including financial; and,
- illuminates the relationship among the three linked elements of sustainability – economic, environmental, and social.

The GRI also aims to assist organizations report:

- in accordance with well-established, widely accepted external reporting principles, applied consistently from one reporting period to the next, to promote transparency and credibility;
- in a format that is easy to understand and that facilitates comparison with reports by other organizations.

In March 1999, the GRI released the Sustainability Reporting Guidelines as an exposure draft for public comment and testing through the spring of 2000. Twenty-one companies from around the world pilot-tested these guidelines and a number of companies, such as Eastern Group, General Motors and Procter and Gamble, chose to publish their 1999 corporate sustainability reports following the exposure draft Guidelines. Unfortunately, the mining industry was not active in this initial pilot-testing phase.[8]

In addition, a wide range of other stakeholders were asked to submit their critical review of the exposure draft Guidelines. This testing period was essential in gathering crucial feedback from both report users and report maker alike. It was also instrumental in increasing the relevance and applicability of the Guidelines and in helping to build consensus among a wide range of views and cultures. After much consultation and revision, the June 2000 GRI Sustainability Reporting Guidelines were released.

UNEP/Sustainability Ltd Engaging Stakeholders Programme

Current Reports:
1. Company Environmental Reporting, 1993
2. Engaging Stakeholders – Volume 1 the 1996 Benchmark Survey
3. Engaging Stakeholders – Volume 2 the Case Studies
4. 1997 Benchmark Survey
5. The CEO Agenda
6. The Non-Reporting Report
7. The Social reporting Report
8. The Internet Reporting Report
9. The Oil Sector Report
10. The Life and Science Report

Future Reports:
1. 2000 Benchmark Survey
2. The Automotive Sector

For further information please see www.sustainability.co.uk

The June 2000 GRI Sustainability Reporting Guidelines:
The June 2000 GRI Sustainability Reporting Guidelines provide a framework for reporting that promotes comparability between reporting organizations while recognizing the practical considerations of collecting and presenting information across diverse reporting organizations.[9]

The Guidelines do not:

- provide guidance for implementing data collection, information and reporting systems, or organizational procedures for preparing reports;
- contain guidance on monitoring performance or on verification practices;
- present standards for performance.

Organizations Represented on the GRI Steering Committee

Association of Chartered Certified Accountants (United Kingdom)
Canadian Institute of Chartered Accountants
CECODES (Colombian Business Council for Sustainable Development)
Centre for Science and Environment (India)
Coalition for Environmentally Responsible Economies (United States)
Council on Economic Priorities (United States)
Environmental Auditing Research Group (Japan)
General Motors Corporation (United States)
Green Reporting Forum (Japan)
Institute of Social and Ethical Accountability (United Kingdom)
Investor Responsibility Research Center (United States)
ITT Flygt (Sweden)
New Economics Foundation (United Kingdom)
SustainAbility, Ltd. (United Kingdom)
United Nations Environment Programme
World Business Council for Sustainable Development
World Resources Institute

Many other stakeholders are actively involved in GRI through their participation in technical working groups, seminars etc. Please see www.globalreporting.org for further information.

The June 2000 GRI Guidelines include a strong focus on three linked elements of sustainability. Environmental indicators were prominent in the March 1999 exposure draft of the GRI Guidelines and were therefore reviewed and assessed in the pilot-testing phase. The social and economic indicators in the June 2000 GRI Sustainable Reporting Guidelines are more experimental and require a thorough testing and assessment period during 2000-2002. In addition, it should be noted that the three elements of sustainability are outlined in the Guidelines as separate reporting elements. However, over time, the GRI will move towards a more integrated reporting framework. This has begun with the 'integrated indicators' described in the Guidelines.

Linked elements of sustainability
Economic: including, for example, wages and benefits, labour productivity, job creation, expenditures on outsourcing, expenditures on research and development, and investments in training and other forms of human capital. The economic element includes, but is not limited to, financial information.
Environmental: including, for example, impacts of processes, products, and services on air, water, land, biodiversity, and human health.
Social: including, for example, workplace health and safety, employee retention, labour rights, human rights, and wages and working conditions at outsourced operations.

The June 2000 GRI Sustainability Reporting Guidelines include the following:

Part A: Introduction and General Guidance
Background on the need for and nature of the GRI, plus general guidance on the design and applicability of the Guidelines.
1. What Is the Global Reporting Initiative?
2. Why Is there a Need for the GRI?
3. What Is the History and Evolution of the GRI?
4. What Do the Guidelines Provide?
5. What Is the Value of Using the Guidelines?
6. Who Should Use the Guidelines?
7. Using the Guidelines – Specific Issues
8. Verification of GRI Reports
9. Relationship of the Guidelines to Other Initiatives

Part B: Reporting Principles and Practices
Fundamental underpinnings, concepts, and practices that promote rigour, comparability, and reliability in reporting.
1. Underlying Principles of GRI Reporting
2. Qualitative Characteristics for GRI Reporting
3. Classification of Performance-Reporting Elements
4. Ratio Indicators
5. Disclosure of Reporting Policies

Part C: Report Content
The framework for structuring a GRI report, specific content, and guidance for compiling the various parts of the report.
1. CEO Statement

2. Profile of Reporting Organization
3. Executive Summary and Key Indicators
4. Vision and Strategy
5. Policies, Organization, and Management Systems
6. Performance

Part D: Annexes
Additional guidance and resources for using the Guidelines
1. Resources for Selecting and Applying Indicators
2. Guidance on Incremental Application of the Guidelines
3. Guidance on Verification
4. Guidance on Ratio Indicators

While much attention is paid to Part C – Report Content, Part B of the GRI Guidelines: Reporting Principles and Practices is also worth highlighting. This section outlines some key principles and practises that are crucial to ensuring that GRI Reports are easy to use, compare, and verify. Many of these principles are drawn from best practice in financial reporting. They include for example, the reporting entity principle which requests reporters to clearly define the boundary of the organization adopted for the report.

As of publication of this article, the June 2000 GRI Sustainability Reporting Guidelines have been translated into Dutch English, French, German, and Japanese and can be downloaded from http:///www.globalreporting.org. It is expected that the Guidelines will be updated in 2002 taking into account feedback received.

An Opportunity for the Mining Industry:

Getting started

For those mining companies embarking on the reporting process, the GRI Sustainability Reporting Guidelines provide an excellent starting point. The Guidelines will assist companies in engaging their stakeholders and reporting in a manner which meets their stakeholders needs. In addition, the GRI Guidelines are a tool for decision making at three levels.[10]

1. At the level of the governing body (e.g. board of directors) and for senior management, the Guidelines provide an internal vehicle for evaluating the consistency between the organization's economic, environmental, and social policy and its actual performance. The increased uniformity in reporting facilitated by the Guidelines will help reporting organizations to compare themselves with others and to recognize improved performance.
2. At the operational level, the Guidelines provide a logical structure for applying sustainability concepts to the organization's operations, services and products. They also help guide the development of data and information systems for setting and tracking progress towards economic, environmental, and social goals.[11]
3. From a communications standpoint, the Guidelines provide a framework for effectively sharing and promoting dialogue with internal and external stakeholders regarding the organizations accomplishments and challenges in achieving its goals.

While the GRI Guidelines provide a solid framework for companies to report on the economic, environmental and social aspects of their performance, the Guidelines can also be used incrementally. For those companies preparing their first report it may be difficult to report on all of their operations or on all of the three linked aspects of sustainability. The GRI Guidelines recognize these difficulties, while at the same time stressing that it is essential for a reporting organization to state precisely in the profile section of its report what is included and what is excluded, and to indicate how it intends to expand coverage in the future. [12]

Sector specific indicators

The future will see increasing demand from governments and inter-governmental organizations for sector-wide reporting. This will enable greater detail and comparability for companies in the same line of business. It will require the development of sectoral indicators to supplement the core, generic reporting framework.

Many mining companies have embarked on this process already. Noranda for example, reports on what it calls 'eight indicators of sustainable development: sulphur dioxide (SO_2) emissions in our copper business, metal emissions to air, energy consumption (which implies to a large extent greenhouse gas emissions), minimizing our footprint, community dialogue, safety, profitable growth and environmental capital expenditures.'

The GRI Guidelines include indicators that are relevant for all organizations – generally applicable indicators – while also recognizing the need to be flexible to allow for organization-specific indicators reflecting, for example, the industry sector, geographic location, and the concerns of stakeholders.

GRI does intend to develop, in a multi-stakeholder fashion, sector-specific indicators to supplement the indicators in the June 2000 Guidelines. The mining industry has been one of the first industry sectors to approach GRI in a proactive manner. Joint work is expected to begin in early 2001. It will help in designing and testing a process for future sector-specific "supplements" to complement the core guidelines.

Innovation

The GRI guidelines can also assist leading reporters in the mining industry to address their environmental, social and economic performance in an integrated fashion. The Guidelines currently propose two main types of integrated indicators: systemic and cross-cutting indicators.

Systemic indicators reflect a movement towards linkage and harmonization between organization-level information and sectoral, national, regional, and global scale information. They link performance at the micro-level with economic, environmental, or social conditions at the macro-level. This will become increasingly important as companies work with national governments to implement the targets set out in international agreements and conventions.

The following are generic examples of systemic indicators:

- wages and benefits, or investments in research and development, at the organizational level expressed in relation to sectoral or national totals;
- workplace accident or discrimination cases at the organizational level expressed in relation to regional or sectoral totals;
- an organization's emissions expressed relative to globally sustainable levels based on biophysical limits defined by governments or international agreements.

Cross-cutting indicators bridge information across two or more of the three elements of sustainability – economic, environmental, or social – of an organization's performance. The following are examples of this type of indicator:

- a composite measure of diversity (economic–social–environmental);
- eco-efficiency (economic–environmental); and,
- externalized costs of emissions (economic–social or economic–environmental).

In some instances, integrated indicators combine systemic and cross-cutting approaches. For example, expressing an organization's air emissions in relation to regional totals as well as estimates of human health effects of such emissions combines the systemic (micro–macro) with the cross-cutting (environmental–social) dimensions of integrated indicators.

For those companies in the mining industry that wish to remain at the cutting edge of corporate transparency, developing and reporting on performance in a systemic and integrated fashion is certainly a challenge.

Supporting the GRI

Most companies strongly advocate that reporting remain voluntary. At the same time, some are quietly calling for a common framework to achieve greater efficiency and utility of reported information. These leading companies have gained considerable experience and perhaps some competitive advantage through years of reporting and would now like to see a 'level playing field'.

"I believe that ... voluntary public reporting promotes greater transparency for ... companies, and improves community confidence in our sector as a whole. It follows, therefore, that institutions in our society that rely on community confidence – such as government departments, media outlets, and community based organizations – might well consider embracing the highest standards of public reporting on matters such as environment, safety, and community relations. Regrettably, this has not yet been the case. I am left to ponder why."

Hugh Morgan, CEO of WMC

The GRI has consistently remained agnostic about any kind of mandatory reporting. At the same time, government initiatives in Japan, the European Union, United States and other countries are showing increasing interest and uptake of the Guidelines. In any case, the GRI is seeking to ensure that the GRI Guidelines become the generally accepted sustainability reporting framework. In order for this to happen, many companies – including those in the mining industry – need to

use the GRI Guidelines and become involved in the multi-stakeholder GRI process. We hope this article has inspired you to do just that.

Notes

[1] 3 June 2000 Global Reporting Initiative (GRI) Sustainability Reporting Guidelines

[2] Fritz Balkau and Andrew Parsons, UNEP DTIE, 1999 article 'Emerging Environmental Issues for Mining in the PECC Region'. Available at http://www.uneptie.org

[3] ibid

[4] June 2000 Global Reporting Initiative (GRI) Sustainability Reporting Guidelines

[5] KPMG International Survey of Environmental Reporting 1999

[6] June 2000 Global Reporting Initiative (GRI) Sustainability Reporting Guidelines

[7] June 2000 GRI Sustainability Reporting Guidelines on Economic, Environmental and Social Performance

[8] Pilot test companies include: Baxter International, USA; The Body Shop International, UK; Bristol-Myers Squibb, USA; British Airways, UK; Electrolux, Sweden; Excel Industries, Ltd., India; Ford Motor Company, USA; General Motors, USA; Henkel Chemicals, Germany; IT1/Flygt, Sweden; KST Hokkaido, Japan; NEC Corporation, Japan; Novo Nordisk, Denmark; Procter & Gamble, USA; Riverwood International, USA; SASOL, South Africa; Shell Petroleum, UK/The Netherlands; Sunoco, USA; TXU Europe (Eastern Group), UK; VanCity Savings Credit Union, Canada.

[9] June 2000 GRI Sustainability Reporting Guidelines on Economic, Environmental and Social Performance

[10] ibid

[11] ibid

[12] ibid ◆

ENVIRONMENT

Home - News
About MRF Environment
Information Releases and Speeches
Post Your News
Upcoming Events and Updates
Mining and the Environment
Current Issues
Education
Berlin II Guideline
Romania - Tailings Spills
Post Baia Mare Initiatives
- Cyanide Code
- Regulators' Workshop
- Emergency Preparedness in Mining

Technical Issues
Documents
Book Reviews
Questions and Answers
Databases
Business Directory
Related Sites
Search

Disclaimer

Go back to MRF Home
Copyright © UNEP/UNCTAD 2000

Mineral Resources Forum - Environment
(www.natural-resources.org/environment)

Do you sometimes have problems finding current, factual, easily accessible information about issues relating to mining and the environment? Consult the **Environment** section of the Mineral Resources Forum (MRF) website.

Intended for decision makers and policy development, information on the MRF is regularly updated to provide information on the full range of environmental issues related to the mitigation of environmental damage, planning for mine closure, disposal of hazardous wastes and abandoned mines. The site hot links to governments, industry associations, international commodity study groups, professional associations, NGOs and other representatives of civil society. Full reports on UNEP assessment missions (e.g. Baia Mare and Baia Borsa accidents), technical information on chemicals of concern (eg. cyanide and mercury), technical and socio-economic issues that arise during the "life cycle" of mineral resources including production, use, recycling, reuse, and return to the natural environment as well as reports from on-going UNEP initiatives are available to keep policy makers and interested stakeholders approsed of developments. Individuals are also encouraged to participate in on-line discussions on current issues and events. The increase in hits per month from under 4,000 in April 1999 to some 18,000 in November 2000 from all regions of the world testifies to the increasing usefulness of the MRF.

UNEP's goals are to encourage the incorporation of environmental criteria into industrial development plans; to facilitate the implementation of procedures and principles for protection of the environment; to promote preventive environmental protection through cleaner production and other pro-active approaches; and to stimulate the exchange of information and experiences of policy makers, NGOs and interested stakeholders around the world. The MRF covers a range of mining, mineral processing and metals impacts on the natural environment and allows for direct input of events from users.

MRF was established as an initiative of the United Nations Conference on Trade and Development (UNCTAD) with financial assistance from the Government of the Netherlands. The United Nations Environment Programme, Division of Technology, Industry and Economics (UNEP DTIE) is a principal partner in the Environment section of MRF.

UNEP DTIE is looking for partners who are willing to manage thematic aspects of environmental issues associated with minerals, metals and sustainable development. Partners may be governments, industries, NGOs, associations, academia and research institutes able to assist by providing feedback and by contributing information of their own.

If you have questions or suggestions, please send them to tozawa@unep.fr or minerals. forum@unep.fr

Mining Industry Report Comparison

Key:

✔ Topic described in text of article in *Mining Environment Magazine*, March 2000

* Site report only

	BHP Company Ltd.	Cambior Inc.	Falconbridge Ltd.	Homestake Mining Co.	Noranda Inc.	North Ltd.	Pasminco Ltd.	Placer Dome Asia Pacific *	Placer Dome Inc.	Placer Pacific Ltd.	Rio Tinto plc	Sasol Ltd.	Shell Coal Pty Ltd.	WMC Ltd.
Environmental Management														
Environmental management structure & responsibility	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔
Environmental policy	✔				✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Audits & review	✔	✔			✔		✔	✔	✔	✔	✔	✔		✔
Compliance	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔		✔
Clean-up operations				✔						✔				
Compensation payments	✔			✔	✔				✔	✔			✔	
Sustainable development	✔		✔		✔		✔	✔	✔	✔	✔		✔	✔
Environmental training & internal communication		✔	✔	✔	✔		✔		✔	✔	✔		✔	✔
Environmental expenditure/investment	✔		✔	✔	✔				✔	✔		✔		✔
Biodiversity/conservation issues	✔	✔							✔			✔	✔	
International Activities Programmes	✔	✔	✔	✔	✔	✔	✔		✔	✔		✔	✔	
Community & Social														
Community relations/programmes	✔	✔	✔	✔		✔	✔		✔	✔	✔	✔	✔	✔
Stakeholder consultation	✔		✔		✔	✔	✔		✔	✔	✔	✔		✔
Product stewardship					✔					✔				
Health & Safety														
Health & safety issues	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	
Lost-time/injuries/fatalities	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	✔	
Exposure to hazards		✔			✔		✔	✔	✔		✔		✔	
Emergency planning & response	✔	✔	✔		✔			✔			✔		✔	✔
Contaminated Land	✔													
Company Operations														
Resource use														
Energy consumption	✔		✔	✔	✔		✔	✔		✔	✔	✔	✔	✔
Raw materials use			✔	✔	✔			✔	✔	✔	✔	✔		✔
Water Consumption	✔		✔	✔	✔		✔	✔	✔	✔	✔	✔		✔
Land Use (surface area)	✔		✔	✔	✔			✔	✔	✔	✔	✔	✔	✔
Site-specific data	✔		✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔
Site-specific targets							✔							✔
Outputs														
Air Emissions	✔		✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔
Water/effluents	✔	✔		✔	✔			✔	✔	✔	✔	✔		✔
Hazardous waste	✔		✔	✔	✔			✔		✔	✔	✔	✔	✔
Solid waste	✔		✔	✔	✔			✔		✔	✔	✔	✔	
Land disturbance/rehabilitation/decommissioning	✔	✔	✔	✔	✔			✔	✔	✔	✔	✔	✔	✔
Site-specific data	✔		✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔
Site-specific targets							✔							✔
Report Information														
3rd party statement	✔	✔		✔		✔	✔		✔		✔		✔	✔

Source: London Mining Journal/MEM, March 2000

Mining and sustainable development: associations hold key to programme of change

Anita Roper, WMC, on secondment to the Global Mining Initiative, London, UK.

Abstract

Industry associations and leading mining, minerals and metals companies are working hard to advance elements of the industry's sustainable development agenda. There has been tremendous progress in awareness and implementation of sustainable development principles in the last three years. Furthermore, in 2000 a number of companies within the industry started a new, comprehensive programme called the Global Mining Initiative (GMI). This programme brings together many of the largest mining minerals and metals companies in a leadership exercise, to help ensure that in the new century the industry and others work together to contribute to sustainable patterns of economic development. The industry's associations form a key part of the GMI. Producing a more effective global network for external representation of the industry is one of the strategic challenges. The associations are the industry's natural vehicles to deliver the most effective follow-through and leverage for the outcomes of an independent analysis of how the industry should contribute to sustainable development.

Résumé

Les associations professionnelles et les grandes entreprises d'exploitation minière, de traitement des minéraux et de transformation des métaux déploient de gros efforts pour faire progresser certains aspects du programme de ce secteur pour un développement durable. Et, de fait, la sensibilisation aux principes du développement durable et leur mise en oeuvre a fait d'énormes progrès ces trois dernières années. Plusieurs entreprises du secteur ont en outre lancé en 2000 un nouveau programme de grande envergure, baptisé Global Mining Initiative (GMI), qui associe la plupart des grandes entreprises d'exploitation minière et de métallurgie aux entreprises d'autres secteurs pour qu'en ce nouveau siècle des modes de développement économique durables soient adoptés. Les associations de ce secteur sont un des acteurs clé de la GMI. Etablir un réseau mondial plus efficace pour représenter le secteur à l'extérieur est l'un des défis stratégiques de cet engagement. Les associations professionnelles sont un véhicule naturel pour donner suite à l'analyse des moyens à mettre en oeuvre pour contribuer à un développement durable et en exploiter les conclusions de façon indépendante.

Resumen

Las asociaciones industriales y las principales industrias mineras y metalíferas están trabajando sin descanso para presentar los elementos de la agenda de desarrollo sustentable de la industria. En los últimos tres años se logró un progreso enorme en cuanto a conscientización e implementación de principios sobre desarrollo sustentable. Además, en el año 2000 una cantidad de empresas dentro de la industria comenzaron un nuevo programa intensivo denominado "Global Mining Initiative" (Iniciativa Minera Global) que reúne a un importante número de las principales empresas mineras y metalíferas en un trabajo para colaborar con los patrones sustentables del desarrollo económico. Las asociaciones de la industria forman una parte esencial de este programa. Uno de los desafíos estratégicos es crear una red global más efectiva que represente externamente a la industria. Las asociaciones son las vías naturales de la industria para el seguimiento efectivo y la adecuación de los resultados de los análisis independientes respecto a la manera en que la industria debería contribuir al desarrollo sustentable.

Introduction

The mining industry world-wide is challenged by its past practices, and more recently, by the need to be better prepared for a different future. Society's expectations of the mining, minerals and metals industry are that it should continue to provide a vast range of essential economic resources, reliably, at an affordable cost, and in a manner that is careful of the environment and produces benefit for communities.

The sector must respond to these changing expectations and meet the challenge. Living successfully with these higher expectations means delivering a high level of performance consistently, and being seen to be doing so. To achieve this, sustainable development provides the best framework within which to address issues such as environmental performance, the fair distribution of economic benefits, human rights and community consultation, as well as product stewardship during the metals life-cycle.

Three years ago, in the first thematic publication on *Mining and Sustainable Development*, George Miller, then President of the Mining Association of Canada, described associations' policies and programmes regarding management approaches to the improvement of environmental performance. These included corporate responsibility and codes of practice, voluntary targets for emissions, public reporting on corporate environmental performance, topical environmental issues such as greenhouse gases and energy use, as well as discharges to the marine environment, transfrontier issues such as international trade in wastes and other aspects of environmental and social performance.

During the last three years there have been many developments within the mining, minerals and metals industry. There has been:

- greater concentration of companies within the industry;
- a move to integrate environmental, social and economic considerations into the way the industry does business under the rubric of sustainable development;
- the demand for and provision of increased transparency of companies' operations;
- greater involvement of those stakeholders who have an interest in the industry; and
- the establishment of the Global Mining Initiative (GMI) – a programme started by mining, minerals and metals companies to respond positively to society's changing expectations.

This article discusses policies and programmes by industry associations, in particular national associations that have been put in place over the last three years to respond to developments. There has been much progress but it must be recognized that the tasks are challenging and no one group has all the answers. The article also touches on the way associations are being called upon to help move forward the sustainable development agenda arising from the independent analytical work of the Mining Minerals and Sustainable Development (MMSD) project initiated by the GMI.

Specifically, the article describes:

- The integration by the associations of the three pillars of sustainable development (economic, environmental, social).
- The tools associations use to:

- assist members in meeting the goals of sustainable development;
- ensure greater transparency of operations; and
- involve stakeholders.

◆ Future challenges facing the industry as seen by the associations.

Integration of environmental, social and economic factors

Many of the associations surveyed incorporate the three pillars of sustainable development in their work programme, some in a more integrated manner than others. In particular, the Minerals Council of Australia (MCA) has reviewed and expanded the Australian Minerals Industry Code for Environmental Management; the Mining Association of Canada (MAC) has commenced a sustainable mining initiative; Euromines has developed guidelines on sustainable development and actively participates in the EU project on 'Voluntary Initiatives & Sustainable Development in the Non-Energy Extractive Industry; the Consejo Minero of Chile is developing a policy on sustainable development; and the International Council on Metals and the Environment has incorporated sustainable development into its mandate.

The most comprehensive national mining industry code of practice to date has been developed by the MCA. This was launched in 1996 and has been reviewed recently. Signatories to the code commit to a number of values including:

◆ the integration of environmental, social and economic considerations into decision making and management, consistent with the objectives of sustainable development;

◆ openness, transparency and improved accountability through public environmental reporting and engagement with the community;

◆ compliance with all statutory requirements as a minimum;

◆ a continually-improving standard of environmental performance; and

◆ through leadership, the pursuit of environmental excellence throughout the Australian minerals industry.

Commitment to the code brings with it a number of obligations: progressive implementation of the code; production of an annual public environment report within two years of registration; completion of an annual code-implementation survey to assess progress against code principles; and verification of the survey results by an accredited auditor at least once every three years.

Any company can become a signatory to the code, including ones that are not members of the MCA. Other associations are encouraged to endorse the Australian Minerals Industry Code. For example, the Chamber of Minerals and Energy of Western Australia has endorsed the code and actively encourages its members to adopt it.

The Mining Association of Canada established a task force to launch a "sustainable mining initiative". The goal is "to continue to earn the opportunity to thrive and contribute by demonstrating the social relevance and value of our industry through a stewardship process that aligns our actions with the evolving priorities of our stakeholders." During 2000, research with internal and external stakeholders will help provide focus on the critical areas where changed performance is required by the industry in order to achieve the goal. It is expected that the initiative will move into a more active phase in 2001. The process of change and consultation with stakeholders is envisaged as an on-going process.

Sustainable development thinking is integrated into many of the activities of the South African Chamber of Mines. For example, in May 1999, the Chamber and its members committed themselves to "environmentally responsible mining" where environmental impacts of all mining activity are built into mining plans. Compatibility is sought between wealth and job creation on the one hand and environmental conservation on the other.

One of the newer national industry associations, Consejo Minero, represents Chile's large-scale mining companies. It is in the process of developing its policy on sustainable development. The final document will reflect the policies of both its member companies and those of other industry organizations.

The International Council on Metals and the Environment (ICME) has changed its mandate from the promotion of environmental policies and practices to the promotion of sustainable development policies and practices related to the mining and production of primary metals. This is incorporated into the mandate of ICME and is intended to ensure the safe production, use, recycling and disposal of metals.

◆ An example of an association at the local level active in applying sustainable development principles is the Chamber of Minerals and Energy of Western Australia which operates an integrated programme covering all of the major issues faced by the minerals and energy industries. The Chamber's vision is for a vigorous and profitable industry operating in tune with the aspirations of the community and industry employees, and in harmony with the environment.

Tools to assist members in meeting the goals of sustainable development

The associations employ a variety of tools to assist their members in meeting the goals of sustainable development. Among these are:

◆ Guidelines
◆ Training
◆ Workshops
◆ Seminars and publications

Guidelines are a common tool used to encourage and assist members. Euromines has developed guidelines on sustainable development for the European mining sector. Members of Euromines shall conduct their activities according to the principles of sustainable development, under the headings of "economic, environment and social".

The Chamber of Mines of South Africa has published a number of environmental guidelines including *The Rehabilitation of Land Disturbed by Surface Coal Mining in South Africa* and *Pollution Problems and Hydrological Disturbances Resulting from Increased Underground Extraction of Coal.* Work is currently underway on guidelines on public participation and on management of cyanide use in gold extraction.

In 1998, the MAC published a guide to the management of tailings facilities. This was developed as an extension of MAC's Environmental Policy and Environmental Management Framework. It incorporates a management system approach rather than a purely technical one. Since its publication, MAC has held a number of workshops with its members to ensure the effective use and application of the guide.

MAC has also adopted and released a policy on climate change and set a target for further reductions in direct and indirect industry emissions of greenhouse gases. It has published a manual: *Strategic Planning and Action on Climate Change – A Guide for Canadian Mining Companies.*

As part of the Greenhouse Challenge in Australia, both the MCA and the Western Australia Chamber of Minerals and Energy have facilitative agreements with the Government under the Greenhouse Challenge programme. The agreements commit the associations to encouraging and facilitating greenhouse gas emission abatement by member companies and to report annually on their activities and achievements.

The Chamber of Minerals and Energy of Western Australia has co-published two sets guidelines on relationships with farmers and pastoralists: a *Code of Conduct for Mineral Exploration on Pastoral Leases* and a *Code of Practice for Exploration in Environmentally Sensitive Areas.* In addition, in 2000, they released a set of principles to guide consultation on aboriginal heritage issues between member companies and indigenous groups.

The Japan Mining Industry Association has developed a *Voluntary Action Plan for Environmental Preservation by the Non-ferrous Metal Mining Industry.* It contains global warming control measures to encourage more energy conservation and to increase efforts towards prevention of global warming. It promotes active recycling to reduce industrial waste release as well as development of an environmental management system demonstrating the latest technology and promotion of technology transfer. Targets have been included where appropriate.

The Cámara Minera de México has agreements with the Mexican Government to promote good environmental practice and is working on the development of guidelines and technical standards for the management of all phases of mining operations.

Small companies often rely more on their associations at both the national and state/provincial level for support. For example, at the national level, the Chilean Association, SONAMI has represented small mining companies in Chile for over 100 years. SONAMI has an environmental policy through which members are encouraged to comply with various communications and training activities.

While SONAMI does not have a formal code of practice, they have published a manual on *Best Environmental Practices in Mining Exploration*

Activities. They are following up with a manual on *Best Environmental Practices in Small Mining Operations*. SONAMI uses international expertise particularly from Canada and the United States working within the *Chilean-Canadian Environment Memorandum of Understanding* and implementing environmental management systems training in medium to small mining companies.

Key roles of associations are training, education and dissemination of information, fields in which all associations have programmes.

State industry associations also play an important role as often many of their members are smaller size companies. The Chamber of Minerals and Energy of Western Australia holds regular workshops and seminars and produces guidelines to assist member companies in improving their practices. Recent examples include workshops on salt lake ecology, and occupational health and safety in the minerals industry, and seminars on greenhouse gas emissions and on native title. The Chamber also holds regular meetings of environment, safety and health forums in regional areas to enable site-based practitioners to exchange information and to interact with regulators. The work of this state industry association is typical of that of other regional associations.

Associations also publish case studies on good performance as a means of transferring learning between members. ICME has published a number of case studies on tailings management, on environmental practices in mining and metallurgical processes, on the management of cyanide in gold extraction and on mining and indigenous peoples.

The MCA participates in joint industry and government production of the *Best Practice Environmental Management* modules for various aspects of mining, including issues such as tailings containment, acid mine drainage, rehabilitation, etc.

The Western Australia Chamber has published three editions of *Mining and Community: A Growing Relationship*, to highlight examples of best practice in environmental and community relationship management in the industry.

Many of the examples above relate to the "environmental" pillar of sustainable development. However, the tools described – guidelines, training, workshops and seminars, and publications – can also be used to assist members in meeting the goals of the other two pillars of sustainable development.

Programmes to ensure greater transparency of operations

The level of transparency of mining, minerals and metals operations has increased in the last three years.

Reporting takes different forms. Many companies produce environmental reports on their performance and a growing number of them also cover a range of social and community issues. Under the Australian Minerals Industry Code, signatories are required to produce an annual public environment report within two years of signing up to the code.

Some industry associations publish reports on a sector-wide basis. MAC publishes an *Environmental Progress Report* every year detailing emissions and members' initiatives on a sector-wide basis. The programme complements MAC's Environmental Policy and Environmental Management Framework. Both are conditions of membership of MAC. MAC's 1999 report, the fifth such document, included reporting on recycling for the first time, and also highlighted the ongoing improvement MAC members are making in reducing releases of major ARET-listed substances (Accelerated Reduction/Elimination of Toxic substances), such as arsenic, mercury, and hydrogen sulphide.

Under the Greenhouse Challenge Agreement with the Australian Greenhouse Office, both the MCA and the WA Chamber of Minerals and Energy produce reports on member company participation in the program.

The work of associations has brought about increasing interaction with stakeholders who have an interest in the activities of the mining industry.

The MCA has established an External Environmental Advisory Group to provide independent advice to its Environment Committee. The advisory group provides a forum through which the minerals industry can – with a view to continually improving its performance – constructively address industry, environmental and related social issues by taking into account community expectations.

The advisory group will identify issues of interest and concern to the community relating to the environmental and related social performance of the minerals industry; provide an annual report on its findings which may include recommendations for improvement of the industry's environmental performance; and provide advice on the industry-wide assessment of progress in implementing the Australian Minerals Industry Code for Environmental Management mentioned earlier.

MAC has engaged in a number of multi-stakeholder processes over the years and is now a members of a "Species at Risk Working Group", along with the Canadian Pulp and Paper Association, the Canadian Nature Federation, the Canadian Wildlife Federation and the Sierra Club of Canada.

The South African Chamber of Mines, like many other national associations has formal ongoing dialogue with NGOs and community groups and meets regularly with labour unions, government departments, academics, consultants and suppliers to the industry. It has also established a joint website to assist communication between mines and local communities. The Chamber's gold mining members recently set aside about US$1.4 million for a rural development strategy. The money will provide seed funding for job creation projects in rural areas of South Africa and neighbouring countries hardest hit by job losses from gold mine retrenchments.

At the state level, one association, the Chamber of Minerals and Energy of Western Australia, has opened up associated membership to a non-industry body. The Yamatji Land and Sea Council which represents the mid-west and Pilbara regions of Western Australia recently became an Associate Member of the Chamber in order to move closer to the industry which underpins the economies of the regions it represents.

Future challenges

The associations recognize that the continuous improvement of sustainable development initiatives made so far is essential and that there are more gains to be made.

In the area of social responsibility, there is much to be done at the community level and particularly with indigenous communities close to mining operations. Social issues have not received the degree of focus by government and industry that environmental issues have had over the last 15 years. There appears to be a steep learning curve facing the industry while, on the positive side, there are leaders in the industry that are good role models for others to learn from and who can provide a body of "best practices" to draw from.

Looking ahead, the associations have identified the following key challenges in promoting understanding of, and contributing to, sustainable development:

- Developing and implementing viable compliance mechanisms for signatories to codes of conduct.
- Addressing social issues within codes and guidelines.
- Raising the level of the environmental and social performance of all companies involved in the industry.
- Ensuring that governments implement all three pillars of sustainable development in an integrated way, rather than concentrating on the obvious ones, environment and social.
- Communicating the essential inter-relationship between the three pillars of sustainable development and in particular the essential role that economic performance plays in being able to deliver on environment and social goals.
- Reflecting the industry on a global basis, as distinct from local and regional issues. The performance of companies offshore and the regulatory capacity of governments in developing nations remain an issue.
- Ensuring that objective information is presented to the community in an easily understood form to enable and encourage informed action.
- Ensuring that communication links between all stakeholders are maintained and enhanced.

In Chile, the smaller miners' organization SONAMI faces acute challenges as many of its members fight for economic survival in a climate of low capital investment and market prices. The organization also recognizes that much work still needs to be done on improving member companies' relations with their local communities.

In South Africa, where the most far-reaching restructuring in the history of the mining industry is underway, in response to the demands of the new social and economic order, the challenges include:

- Finding the right balance between the need to promote economic development and employment while protecting the environment and safeguarding the community, bearing in mind the ongoing

time-scales required to judge sustainability.

- Interacting with organizations whose balance lies elsewhere, such as wealthier countries that can afford better environmental protection, and those in poorer countries for whom economic growth is the greater priority.
- Understanding the scope, roles and linkages of mining vis-à-vis social and community issues such as the AIDS epidemic.
- The extent of the role of the association vis-à-vis the role of members.

For the Consejo Minero in Chile, the challenges over the next three years include:

- Balancing the demands of economic development and social progress with the need to minimize the immediate and longer-term impact upon the environment.
- Establishing a mechanism of communication amongst the various stakeholders in a manner that can address the disparity of understanding about the roles and responsibilities of the industry, the government and the community.
- Promoting an appropriate level of commitment by all members in order to secure an improved level of performance and acceptability for the industry.

Associations and the Global Mining Initiative (GMI)

The GMI, as noted earlier, goes directly to the heart of the issue of mining, minerals, metals and sustainable development. One of the challenges facing the GMI is the need to capture and mobilize more effectively the expertise and influence of industry associations through a more effective network of external representative bodies, especially on the international stage, to maximize the industry's contribution to sustainable development.

For the past 20 years industry associations have represented the interests of mining and metals regionally, nationally and internationally with advocacy, scientific research and marketing support. They have functioned as the organizational structure for developing consensus among members, providing input to government agencies, communicating with end users and developing links with the industry's stakeholders. As this article shows, they have become major players in the sustainable development issue.

However, fragmentation of the industry and overlap of memberships and agendas between the associations often mean that stakeholders do not know who to ask in the industry for a strategic viewpoint. The GMI seeks to stimulate a more cost-effective, authoritative and focused model to provide a vehicle for effective follow-up of the outcomes of a study into the "how to" aspects of sustainable development in mining. The model needs to have increased capacity to contribute to rather than react to agendas. Instead of only transmitting industry messages to the world, representative bodies should be able to convey concerns and expectations back to the industry.

Key features of this model are a greater level of mining company senior executive leadership and involvement in associations; a more effective network of national, regional and commodity bodies; and separation of business and market-development roles from policy-oriented science and advocacy functions.

Conclusion

Mining, minerals and metals industry associations have made proactive strides in providing guidance to their industry membership on matters that further the sustainable development agenda.

The GMI programme recognizes that industry associations at all levels, international, regional, national and commodity, are essential to the ongoing dialogue between the mining industry and the wider world.

This review of the progress made by the national associations during the last three years makes it evident that there is a strong platform to build on to further the desired sustainable development practices in the mining industry. Associations will support the industry so that it can continue to provide mineral and metal products to the world while respecting the right of future generations to provide for themselves.

Note:

The information for this article was obtained through a questionnaire sent to a small sample of national associations and the International Council on Metals and the Environment (ICME). The Chamber of Minerals and Energy of Western Australia was included to give a state association perspective. ◆

◆◆◆◆◆

Some environmental management tools for mining – a brief overview

The environmental agenda has now become too complex for ad hoc approaches. The realization that only a "prevention" approach can truly deliver the performance we want has led to the development of a number of specific environment tools that let key stakeholders – principally companies and governments – take more effective (and more cost-effective) approaches.

For governments, *regulatory tools* have sharpened considerably, with more emphasis on upstream application during the planning phase (use of Environmental Impact Assessment, occasionally Life Cycle Assessment, siting restrictions), the design phase (design standards, safe location) and operational phase (pollution standards, waste disposal, emergency response procedures, monitoring). The compilation by UNEP/ DESA of current regulatory approaches gives more details of national practice.[1] A new challenge for the regulatory process generally is now proper interfacing with voluntary industry codes and guidelines. So far the permitting and approval process has either (the most common approach) ignored such voluntary initiatives entirely, or has incorporated entire codes as legal requirement (as occurs in South Africa). In this respect the development of voluntary codes by industry without a clear vision of how the regulator should react to them has perpetuated this parallel approach creating little synergy or collective benefit.

Industry for its part has developed extensive *"in-house" procedures* such as audits, reviews, monitoring and (internal) reporting, guided by company-specific policies, standards, protocols and procedures. The functioning of this is often invisible to outside stakeholders, giving the erroneous impression that nothing is being done.

Collective industry action through sector-wide codes has occurred in only a few countries and has proven difficult to impose on non-members of associations (and sometimes even slow to implement by members). Nevertheless, the new determination by a few associations to make voluntary codes work can be expected to lead to other countries eventually following this path, improving the effectiveness of such instruments. The determination that such codes should remain voluntary has meant that governments have not been ready to amend legislation to give companies greater flexibility in meeting legal standards.[2]

In parallel with this evolution of "control systems" has been the development and use of a number of practical environmental management systems and tools. Some of these have been described in a previous issue of *Industry and Environment*.[3]

Environmental management systems (EMS) have now been adopted by many leading mining companies, although very few have formally certified these under the ISO 14001 standard. An EMS results in a much more systematic and cost-effective approach to an environmental programme than simply taking ad hoc actions on high-profile problems. An EMS is virtually a necessity if a truly preventive approach is to be adopted as it formalizes the actions and contribution from non-environmental "mainstream business" activities of a company. An EMS is also becoming a popular tool for ensuring environmental management along the supply chain as it provides a convenient environmental performance label on other businesses with which a mining company may wish to deal.[4] While this practice is becoming more common in business, industry has nevertheless opposed the use of ISO 14000 as a regulatory requirement by government.

Main Elements of ISO 14001

The six key elements of an environmental management system (EMS) are:

- An environmental policy in which the organization states its intentions and commitment to environmental performance;
- Planning in which the organization analysis the environmental impact of its operations;
- Implementation and operation: the development and putting into practice of processes that will bring about environmental goals and objectives;
- Checking and corrective action: monitoring and measurement of environmental indicators to ensure that goals and objectives are being met;
- Management review: review of the EMS by the organization's top management to ensure its continuing suitability, adequacy and effectiveness; and
- Continuous improvement.[5]

Compiling and synthesizing reliable information for decision making has also become more formalized.

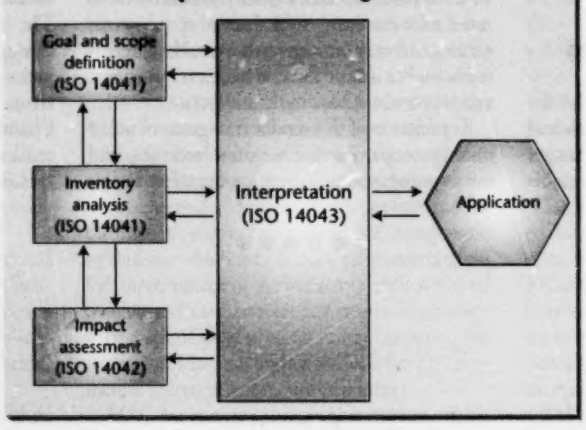
Environmental impact assessment (EIA) is the best known and most widely applied assessment tool, and is particularly applicable to large mining projects in the planning stage. There is a large community of EIA consultants and advisers to assist in compiling the reports. However, company managers often lack experience in effectively managing the integration of such reports into the entire project cycle of a mine. EIA has too often come to be regarded only as a regulatory hurdle – necessary to obtain government approval – rather than as a project optimization tool, despite its obvious benefits to this end (the more so considering the cost and timing of an EIA). Companies would benefit by keeping the EIA report as a living document to guide environmental decision-making during the operational and closure phases of a mine.

EIA still needs to be interfaced with other day-to-day environmental management tools such as EMS, auditing environmental, reporting and so on.

Finally, it can be observed that while much teaching and training is taking place to improve EMS skills of experts, the average mining professional is rarely taught how to manage the EIA process within his company.[6]

Life-cycle assessment (LCA) is another tool which is becoming more important for companies that are examining the implications of their products at the end-use in society. There is a large body of knowledge of LCA procedure and practice.[7] However, practical applications can be complex and subject to numerous assumptions. UNEP and SETAC[8] have recently launched an initiative to improve transportability of data. Even in the absence of quantitative results, the LCA process can lead to valuable insights into the environmental performance of mineral and metal products thus helping companies and governments in making strategic long-term decisions about the direction of future investments and operations (Figure 1).

Figure 1
Steps of LCA according to ISO



A further assessment tool that has yet to realize its full potential is *Environmental technology assessment* (EnTA). This is a systematic way of evaluating the environmental implication of a technology option, before it is put in place (Figure 2).

EnTA follows a similar logic to EIA and LCA in its methodology, but being non-site or product-specific, it can easily deal with an entire technology concept (for example, heap leaching or submarine tailings disposal) as well as specific plant items. A simplified EnTA procedure is shown above. While the procedure is relatively straightforward, a guidance manual for EnTA application has recently been developed by UNEP. In February 2000 this manual was pilot tested by UNEP and its partners on cyanide and battery recycling technologies respectively and is now available for trialling on a more widespread basis.

Depending on the initial scoping exercise, EnTA can be applied at a variety of levels, by a range of interested stakeholders, including technology purchasers, assessment bodies and regulatory agencies, and even by the general public when sufficient information is available.

While the assessment procedures above compile information for decision-making in advance of development of a mine, *auditing and public reporting* track the progress that an operating mine is making on its environmental objectives.

Environmental audits may cover a range of issues and situations including discharges and emissions, land degradation, hazardous installations, impact on biodiversity and land use, chemical risks and so on. A full environmental audit is also a prerequisite for the establishment of an EMS. Procedures for environmental audits are available from many sources, including ISO 14011.[9]

While audits may be performed completely in-house, some companies prefer to include outside experts on their audit team to bring a fresh look at various aspects of their operation.

Public *environmental reporting* has become a more common practice among major mining companies and some recent reports have achieved a high degree of sophistication. However, there has not been time to develop a standard approach, common indicators, and a uniform format to such reports. It is therefore difficult to compare the performance of different companies, or to obtain an overview of progress in the mining sector overall. With the evolution of the environmental agenda to include other new elements, some companies are starting to produce "sustainable development" reports where social and ethical issues are included.

The Global Reporting Initiative (GRI)[10] was recently launched by UNEP and a consortium of partners to standardize the reporting format across the entire sustainability agenda, including environmental, social and economic indicators into a single public report. It should be noted that GRI, and indeed environmental reporting itself, is seen by most stakeholders as a voluntary public statement of a company's position. It does not replace mandatory reporting to Government authorities under the conditions of its operating permit or license.

An additional tool that major mines are now starting to use is a systematic approach to emergency prevention and preparedness. There is increasing interest in using the APELL process (*Awareness and Preparedness for Emergencies at Local Level*) which was developed by UNEP with other selected partners in the early 1990s, in particular the chemicals industry. APELL is especially focussed on securing neighbouring communities around a mine against potential hazards from tailings structures, accidental cyanide release, chemical spills, ground subsidence and so on.

The *APELL process* consists of ten steps:

1. Identify the emergency response participants and establish their roles, resources, and concerns.

Economic issues

Mining and the environment: the economic agenda

Olle Östensson, International Trade and Commodities Division, United Nations Conference on Trade and Development (UNCTAD)[1].
Place des Nations, 1211, Geneva, Switzerland

Abstract
Increasing minerals production implies increasing environmental impacts. However, environmental management can offset the trend and reduce the demands made on the natural environment. However, the possibilities for opening new mines may be decreasing due to public perception that mining is damaging to the environment. The problem of how economic and environmental responsibilities can be shared equitably needs to be addressed.

Résumé
Si accroître la production de minéraux signifie augmenter les impacts de cette activité sur l'environnement, la gestion de l'environnement peut inverser cette tendance et réduire les atteintes au milieu naturel. Mais le fait que le public perçoive l'exploitation minière comme une atteinte à l'environnement peut limiter les possibilités d'exploitation de mines nouvelles. Il faut donc se pencher sur la question de savoir comment partager équitablement les responsabilités économiques et environnementales.

Resumen
Aumentar la producción de minerales implica aumentar los impactos ambientales. Sin embargo, la gestión del medio ambiente puede revertir esta tendencia y reducir las demandas ejercidas sobre el medio ambiente natural. No obstante, la reducción de posibilidades de apertura de nuevas minas podría atribuirse a la percepción pública de que la minería es perjudicial para el medio ambiente. Se debe plantear el problema de cómo compartir equitativamente las responsabilidades ambientales y económicas.

The environmental impacts of mining are also an economic issue...

Mining often has a dramatic and highly visual impact on the environment. Perhaps this is why it is one of the economic activities that generates the most environmental controversy. However, its impact is local and is insignificant in terms of the total land area affected[2]. Many other activities have much more serious and wide-ranging effects on human health and ecosystems. Nevertheless, the effects on the landscape are impossible to miss, and they give rise to powerful sentiments.

An important feature of mining is that it can not be relocated. Mining has to take place where the mineral deposits are. If a deposit happens to be in an area that all concerned agree should be protected, it will not be mined. However, such a decision carries a cost. Another deposit, probably with slightly lower ore grades, will be mined instead. As a result, the goods produced from the mineral mined will be slightly more expensive to the consumer. The mining of the slightly lower grade deposit will also result in a larger amount of waste and some negative environmental impact (hopefully, however, smaller than in the case of the first deposit). Less mineral raw materials may also be consumed, and production of substituting materials may entail environmental damage. It is important to be aware that all decisions concerning mining and the environment carry costs, in terms of both environmental impact and material living standards. The objective should be to keep the sum of all these costs as low as possible.

and the economic trends are broadly encouraging...

The past decade has seen stable economic growth at a relatively high level and a very rapid expansion of world trade. This has set the scene for a period of solidly expanding demand for mineral raw materials, particularly in the fast-developing countries of Asia. This ensures ready and growing markets for the products of new mineral producers. The Asian economic crisis resulted in a break in the trend, which, however, now appears to have been temporary. The much-discussed decline in the rate of growth in intensity of use of raw materials, which even led to the coining of the term "dematerialization", has revealed itself to be a force of minor magnitude. If the increase in recycling rates is taken into account, the rate of growth in minerals and metals use continues to be about equal to or slightly higher than that of global GDP, and there is no sign of it slowing down.

In the last few years there has been renewed interest in exploration and investment, particularly in developing countries. Although the statistics are incomplete, all observers agree that foreign direct investment (FDI) in mining is growing at a respectable rate, although possibly somewhat slower than overall FDI. Latin America has become the most important target for both exploration and development while some countries, including Australia, Canada and, in particular, the United States, which dominated the investment scene until recently, have seen exploration spending stagnate or decline. From the point of view of economic development, the new interest in Central Asia and the renewed interest in Africa are particularly encouraging. While the Asian crisis also affected total expenditure on exploration and investment, the shift in geographical focus appears to be persisting. This development has been stimulated, inter alia, by changes in legislation concerning mining and foreign investment in many countries, and by the mobilization of risk capital made possible by liberalized capital markets.

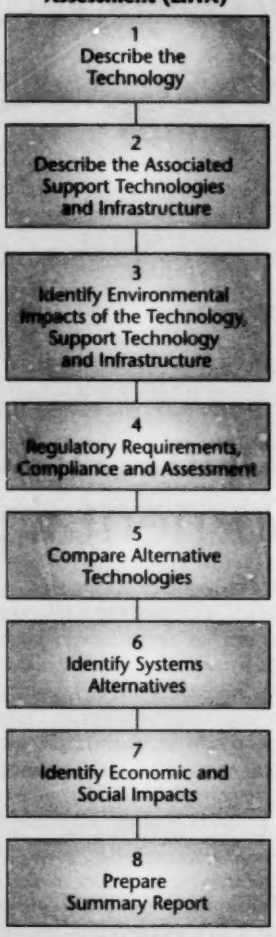
In the early 1980s, exploration by foreign companies in developing countries was usually permitted, but security of tenure linking exploration to mining was weak: exploration companies were not assured of the right to exploit deposits discovered. Foreign direct investment was permitted in

2. Evaluate the hazards and risks that may result in emergency situations in the community.
3. Have participants review their own emergency response plans to ensure a coordinated response.
4. Identify the required response tasks not covered by existing plans.
5. Match these tasks to the resources of the identified participants.
6. Make the changes necessary to improve existing plans, integrate them into an overall community plan, and gain agreement.
7. Commit the integrated community plan to writing and obtain approval from local governments.
8. Educate participating groups about the integrated plan and ensure that all emergency responders are trained.
9. Establish procedures for periodic testing, review, and updating of the plan.
10. Educate the community about the integrated plan.

The APELL process has two major outcomes: awareness and preparedness against risks of neighboring communities; and more effective, coordinated emergency response procedures put in place ahead of possible accidents. It is based on a multi-stakeholder dialogue and negotiations to identify hazards, prepare a response plan and communicate the results.

Achieving these outcomes naturally also results in an actual reduction of risk at mining facilities to the benefit of both workers and the public. UNEP has published extensive guidelines on the APELL process, and the publication of an APELL Handbook for the mining sector is expected during 2001. [11]

Figure 2
Environmental Technology Assessment (EnTA)



Notes:

[1] Mineral Resources Forum-Environment, www.natural-resources.org/environment

[2] UNEP Technical Report 40: Voluntary Industry Codes of Conduct for the Environment; *Industry and Environment* Vol 21, No. 1-2, Jan-June 1998

[3] UNEP Industry and Environment, *Environmental Management Tools*, Vol. 18, No. 2-3, April-September 1995

[4] References on EMS, incl. UNEP references and publications BPEM

[5] References on EMS, incl. UNEP EMS Training Kit and other documents and publication on EMS in BPEM and EMS article in previous *Industry & Environment*

[6] UNEP Environment Impact Assessment (EIA) Training Manual, www.environment.gov.au/epg/eianet/manual.html; International Association for Impact Assessment (IAIA, www. iaia.org), Best Practice in Environmental Management (BPEM) in Mining Program, www.environment.gov.au/ssg/bpem.html.

[7] Towards the Global Use of Life Cycle Assessment, 1999 UNEP; Life Cycle Assessment: What is it and How to do it? 1996 UNEP

[8] Society of Environmental Toxicology and Chemistry, SETAC Office, 1010 North 12th Ave, Pensacola, FL 32501-3367, USA, email:setac@setac.org

[9] From I&E, Vol II, No.4, 1988, Figure 1, page 16, Best Practice Environmental Management in Mining (www.environment.gov.au/net/bpem.html)

[10] www.globalreporting.org

[11] see related article in this publication. Also relevant use the Proceedings of the Workshop on Risk Management and Contingency Planning in the Management of Mine Tailings, Buenos Aires, Nov.5-6, 1998, published by ICME and UNEP and BPEM Guidelines on Risk Management. ◆

most countries, but often only with participation by domestic companies, either state or privately owned. The security of a right to explore has generally been strengthened in recent years, with most mining codes now recognizing that right as exclusive within the exploration area. The link between the exploration right and the right to mine has also been strengthened in most countries. In addition, the mechanisms for settling disputes have been made more acceptable to foreign investors, with many recent investment agreements providing for international arbitration of specified disputes, and with many countries entering into bilateral and multilateral investment treaties that accord investors some form of protection against unilateral actions by host country governments.

Increasing minerals production implies increasing environmental impacts from the mining and processing of minerals. However, environmental impacts do not have to grow at the same rate as minerals production. Improved environmental management can offset the trend and reduce the demands made on the natural environment. Over the past two decades, environmental legislation has been strengthened in almost all countries and this has contributed to reducing the negative environmental impacts of mining. However, ambitious legislation needs to be complemented by effective monitoring and enforcement, which require skills and financial resources. It takes time for information about new methods and technologies aimed at reducing environmental impacts to be disseminated and for the methods to be put into practice widely.

One important aspect of the exploration and development "boom" is the growing interest in medium-size deposits, both of gold and base metals, with a relatively short mine life. These mines have a relatively short start-up period meaning that government agencies are often under considerable pressure to speed up the environmental review and approval process. This could be a source of concern, particularly since the expansion and broadening of interest in developing countries – to some extent a consequence of the general trends towards globalization and liberalization – mean that a large part of new investment is likely to take place in countries which at present have little experience of mine development and limited capabilities as far as monitoring and enforcement are concerned (for instance, in Africa or Central Asia). The governments of these countries are of course anxious to acquire an independent capability to evaluate projects and negotiate with developers as soon as possible. It will be an important task for the international community to extend all possible assistance to them in this respect. Developments will be followed carefully, particularly by the environmental NGO's who will be sure to alert the international public to any cases of environmental damage or indications that environmental management standards are not being observed.

While the trends in developing countries are encouraging from the point of view of world mineral supply and growing incomes, the scope for opening new mines in developed countries is decreasing due to public perceptions of mining as an inherently and unavoidably damaging activity for the natural environment. Several well-publicized incidents of spills from tailings dams in recent years have reinforced these perceptions. As a result, increasingly large areas are being closed to new mineral development. This manifestation of the "NIMBY" (Not In My Back Yard) syndrome may lead exasperated planners and mining companies to ask: Well, if not in your back yard, in whose back yard then? More seriously, the restrictions raise the problem of how economic and environmental responsibilities, including both the responsibility for environmental damage from mining and for providing the world with the raw materials it needs, can be shared equitably.

...as are the trends for environmental management and its costs...

With few exceptions, the costs of environmental protection measures have not had any major effects on the economics of mineral production. Estimates of the costs as a proportion of total production costs vary from negligible to crippling. Those who are trying to demonstrate that the costs are low point to examples of mines where investments made for environmental reasons have led to higher productivity and lower costs, while those who aim to show that the costs threaten the industry's existence quote the full cost of investments, including elements that have little if anything to do with environmental requirements. It is easy to find examples supporting either version of the facts, partly because it is very difficult to identify the exact portion of the investment that is due to environmental objectives and partly because circumstances differ from one operation to another depending on geology, climate and other factors, including, most importantly, whether the investment is made as an addition to an existing facility or in a new one. It appears reasonable to assume that the costs of environmental protection are indeed positive and significant. However, if it were true that environmental measures are a high portion of production costs we would expect to see some clearly identifiable effects, such as higher metals prices, reduced profits of mining companies or unwillingness to explore for new deposits or invest in the development of new mines. In 1992, a reputable consulting firm predicted that "environmental upgrading" would cost the mining and mineral processing industry some US$ 6,000 million and that this would have "an enormous effect on exploration and new smelters as industry cuts back due to the environmental downside".[20] There are no signs of any of this happening, which seems to indicate that the industry has adapted quite well to the introduction of new regulations.

It should be noted that compared to other factors which influence profit levels and for which mining companies have to make provisions, such as fluctuations in metals prices and exchange rates, environmental costs have the important advantage of being (usually) known in advance. In principle, it is therefore easier to take them into account. The industry has demonstrated an impressive capacity to adjust to regulatory changes (usually after first having complained bitterly about the costs), and has achieved results when it comes to reducing environmental impacts that would hardly have been believed a couple of decades ago. This is due partly to the development of new technologies, but above all to the introduction of management and planning methods that integrate environmental impacts in the project planning process from the outset and that do not see environmental mitigation as something to be added as an afterthought once the project design has been decided. Clearly, the industry has realized that the costs of project delays and possible closures due to the need for mitigating measures that were not foreseen but which impose themselves as a result, for instance, of public opinion pressure are likely to be higher than the cost of doing it right from the outset. Thus, the need for costly "end-of-pipe" solutions is diminishing as the industry catches up with and meets regulatory requirements, often at little additional cost.

This does not mean that all is well and that the environmental problems associated with mining can be considered as having been solved. We still have a long way to go to reach the situation where a mine can be closed down and forgotten with no need for monitoring or precautionary measures. Moreover, new and more ambitious targets will continue to be set for the reduction and mitigation of environmental impacts. Mining companies will have to be alert to new developments and prepared to take action to deal with new requirements.

The policy instruments used by governments to ensure that mining is carried out under conditions that minimize the risk to the environment are evolving rapidly, and environmental agencies are acquiring increasing experience and sophistication in the practical application of environmental policies. The popularization of the Polluter Pays Principle has had the effect of making the need to internalize environmental costs more widely accepted (although the principle is often misinterpreted as referring to compensation for environmental damage)[21] and has influenced the way that even traditional "command and control" policies are applied. "Classical" economic instruments to reduce environmental impacts, such as pollution taxes, have yet to find a wide application in mining, for reasons having to do both with public acceptability (the idea that you can "buy the right to pollute" is difficult for many to accept) and practicality, not least the problems of quantification of impacts. At the same time, however, "hybrid" economic instruments aiming at defining liability and ensuring that funds are available for cleanup, such as performance bonds and rehabilitation assurance, have been rapidly accepted and have become part of the mining and environmental legislation in several countries. This type of instrument is likely to form an increasingly important part of the regulatory landscape in the future. It deserves to be emphasized again, however, that governments' capabilities vary, and that many developing country governments with overwhelming demands being made

Environmental issues

Sustainable development and the evolving agenda for environmental protection in the mining industry

Barry Carbon, Head of Queensland Environment Protection Agency, 160 Ann Street, Brisbane, Queensland 4000, Australia

Abstract

Appropriate governmental and industry structures are needed to implement even the most widely accepted principles of environmental protection. Examples relevant to the mining industry are given. The mining industry needs to continue to take further steps to fully embrace the concepts of sustainable development and the triple bottom line despite improved performance and new initiatives. The commitment by the mining industry to "do the right thing", which has often been a motivating factor in the past is most important to environmental protection. Doing the right thing now incorporates a triple goal for the mining industry, to achieve environmental protection, social acceptance and economic benefits from its operations.

Résumé

Des structures gouvernementales et industrielles appropriées sont nécessaires pour que soient appliqués les principes de protection de l'environnement, même quand ils sont largement acceptés. L'article qui suit donne des exemples pris dans l'industrie minière. Bien que ce secteur ait amélioré ses performances et pris de nouvelles initiatives, il doit continuer à prendre des mesures pour mettre en application les concepts de développement durable et du gain sur trois plans (financier, environmental et social). L'engagement de l'industrie minière de "faire ce qu'il faut", qui a souvent été un facteur de motivation dans le passé, est très important pour la protection de l'environnement. Faire ce qu'il faut maintenant, cela signifie pour l'industrie minière atteindre un triple objectif : protéger l'environnement, obtenir l'approbation sociale et tirer profit de ses activités.

Resumen

Se requieren estructuras gubernamentales e industriales adecuadas para implementar incluso los principios más ampliamente aceptados sobre protección ambiental. Se aportan ejemplos relacionados con la industria minera. La industria minera necesita continuar avanzando para abarcar por completo el concepto de desarrollo sustentable y el triple objetivo final a pesar de los mejores resultados y las nuevas iniciativas. El compromiso de la industria de hacer lo correcto, que muchas veces ha sido factor motivante en el pasado, es más importante para la protección ambiental. Hacer lo correcto ahora incorpora el triple objetivo para la industria minera de lograr protección ambiental, aceptación social y beneficios económicos de sus operaciones.

The mining industry has been a focus of criticism in the past. It has been associated with environmental impacts which are visible and intense, and too often the people most impacted by mining have received few tangible benefits. In fact, in the event of environmental disasters, such as the 30 January 2000 incident in Baia Mare, Romania, the local community has suffered environmental, economic and social disadvantages as a result of a mining mishap.

There are many examples of the mining industry not providing adequate benefits to those most impacted throughout the world. However, the recent development of new attitudes within the industry – encompassing environmental protection, sustainable development and community obligations – means there is now room for optimism. A continually increasing commitment to minimizing the adverse environmental impacts of mining is being reinforced by technological advances. Of course major challenges still exist, but they are being met with more open-minded approaches and greater confidence. An example of one such challenge and the responses to it is given in Box 1.

Value systems: the basis of sustainable development

For everyone involved in the environmental debate, there have been milestone events which have marked the evolution of sustainable development. Among the most significant are: the first Environmental Protection Act in the United

States[1]; the World Conservation Strategy of 1980[2]; and the Rio Earth Summit and Declaration of 1992.

The World Business Council for Sustainable Development (WBCSD) has commissioned the International Institute for Sustainable Development (IIED) to manage the Mining Metals and Sustainable Development (MMSD) project as an independent process of multi-stakeholder engagement and analysis with the objective of "identifying how mining and minerals can best contribute to the global transition to sustainable development". MMSD was initiated by the WBCSD as one of a number of projects being supported by the Global Mining Initiative (GMI). In the future, the MMSD project, and its proposed conference on mining and sustainable development in 2002, may be seen as important steps towards sustainable development taken by the global mining industry.

Two important lessons can be drawn from these milestones of sustainable development and other significant past events. Firstly, environmental protection and sustainable development are based on a system of values. While such values have common elements, they do not apply in exactly the same way in every social, cultural or economic situation. It is often helpful, therefore, to formulate values appropriate to a particular situation in order to determine appropriate specific actions. Secondly, sustainable development requires action going beyond the requirements of regulatory control. There is more to be gained from partnerships between business and environmental interests than from confrontation.

A synthesis of the values which emerged from the World Conservation Strategy, and which were given more detailed expression by the UNCED Declaration of 1992, could read as follows: "The world should be good to live in, and to make a living in, for all of us, for our children, and for theirs."

Secondary principles for action can be derived from this primary value statement. The following four are widely accepted: some parts of the environment should be kept natural; animals and plants should be protected from extinction; productive capacity should be protected; and people should be able to live in a clean and healthy environment. These four principles are a prerequisite for sustainable development and apply globally.

Woman getting water at Baia Mare

Since putting these principles into effect requires actions on the part of industry and governments, both must be equipped with the structures needed for implementation. The rest of this article examines some actions and structures relevant to mining. The examples given demonstrate the importance of a commitment to "doing the right thing". Exactly what constitutes "the right thing" depends, of course, on what is appropriate for a particular form of development in a particular context, including consideration of the social and environmental impacts as well as the economics of the development.

What governmental structures are suitable?

There have been ongoing debates about the roles various parts of government should play in environmental protection. Much of the necessary expertise is found in mining agencies, whose primary function is the promotion of mining and minerals exploration. Government environmental agencies have the objectivity which comes from being separate from industry, but they frequently lack the resources to implement the policies they produce.

There are three possible structural models:
1. all environmental activities are allocated to a central environmental agency;
2. all mining-related environmental activities are allocated to the mining agency; or
3. there is a division of responsibilities between agencies.

The third model appears to be the most successful and is not only appropriate for environmental protection, but also for finance, occupational health and safety, and many other areas where the issues addressed by government cut across a number of topics.

This model is based around a central agency (in this case dealing with environment) which oversees policy issues affecting the environment and provides external audits and advice on environmental activities. The agency is responsible for environmental policy, advice to government on yes-no issues such as major new development proposals, and, where applicable, environmental auditing. With regard to operations, specific environmental issues are addressed by the relevant resource agency(ies)– in this case, the mining agency.

What actions should governments take?

In the three-stage approach to environmental protection described below industry is encouraged by government to go beyond regulatory standards and work towards sustainable development.

Stage 1: Prevent obvious problems

Previously, investment and development decisions have left us with acute problems such as industrial air pollution, polluted waterways, and even the after-effects of catastrophes. Such problems affect the environment in a way perceived by reasonable people as unacceptable. Governments attempt to manage these problems by using their powers of intervention and regulation. An example of the acute effects that may occur when environmental disasters occur is the cyanide spill from the tailings pond of a gold smelter at Baia Mare in Romania in January 2000. See Box 2.

The first stage in the process concerns credibility and values as much as it does meeting scientifically defined limits. Governments can lend support to the greater part of industry which is not producing unacceptable environmental impacts by using their powers against those who cause such impacts. One of the greatest difficulties encountered at this stage is that it is not always possible to improve environmental quality without curtailing productivity. This often requires governments to make hard decisions such as whether to apply coercive measures.

Stage 2: Adopt acceptable standards

Once acute problems are being managed, it is possible to move towards setting and enforcing standards for environmental performance in normal operations. The early part of this stage is characterized by command and control approaches, which are subsequently augmented by other instruments.

Box 1

Weipa Summit – Regional commitment by all parties to improve social and economic benefits to the indigenous community

In a move to encourage sustainable social, environmental and economic development the Queensland State Government in northern Australia recently hosted a summit meeting in Weipa, a remote area in the north of the state. It was attended by government, business representatives (including mining operations and other significant industries in the region), social organization representatives and indigenous community leaders. The summit brought the groups together to generate ideas and identify opportunities to drive the region's economic development, promote indigenous business skills and facilitate strategic alliances between the different parties.

A major aim of the summit was to develop projects that would improve the quality of life and break the cycle of welfare dependency for the region's indigenous communities. There was a commitment at the summit that each development proposed for the region would be assessed to ensure it is both environmentally sustainable and acceptable to the indigenous community.

Box 2
Cyanide spill from the tailings dam at Baia Mare in early 2000

In January 2000 a tailings pond from a gold recovery plant in Baia Mare released tonnes of wastewater containing cyanide from the process used to recover gold. The spill affected rivers in Romania, Hungary and Yugoslavia and resulted in the death of virtually all aquatic life in the affected rivers.

The United Nations Environment Programme (UNEP) and the United Nations Office for the Co-ordination of Humanitarian Affairs (OCHA) carried out an investigation of the incident and produced a joint report. The report indicates that deficiencies in the design of the process used, inadequate operating conditions and bad weather contributed to the release of cyanide from the tailings pond.

The plant was operating within the government permits issued to it as a "regular risk". A "regular risk" plant is described as a "closed loop" that would not leak any cyanide during the recovery of the gold. The UNEP report says that the facility was in fact open at two points, allowing cyanide to leak even before the dam was breached.

Some affected towns disconnected water supplies from the contaminated rivers to prevent residents from drinking water containing cyanide. In other areas the sale of most freshwater fish was banned. The social affects of the spill are significant as many of the villages along the affected rivers are dependent on them for their incomes, from the local fishing industry or agriculture. As a result of requests from residents and governments of these areas, a mobile UNEP laboratory has been made available for sampling in the region and a Baia Mare Task Force has been set up by the European Union.

A large number of mines and other recovery plants operate in the area and a number of other spill incidents have occurred in the region and elsewhere since Baia Mare. This has led to actions such as a review of the mining industry's design and operational codes by UNEP, to ensure that the industry makes a positive contribution to sustainable development, while minimizing risks to the local populations and the environment.

UNEP is now working with stakeholders to address questions regarding the mining industry, including:

- Emergency preparedness and response at mine sites;
- Revised design and operating codes for cyanide processes;
- Developing new international standards for fail-safe concepts in tailings dams;
- Reviews of permit and inspection procedures of hazardous mining installations;
- Training workshops for national inspectorates in risk assessments and enforcement; and
- The publication of a guide to best practice water management at mines.

It is at this second stage that actions based on the four secondary principles mentioned above are formalized. Pollution prevention laws are directed at controlling emissions and/or establishing standards (e.g. for air or water quality). In some but not all cases, plans and policies are introduced to encourage the wise use of natural resources. National parks and nature conservation areas ensure that some parts of the environment are kept natural. Laws are passed to protect rare or endangered animals and plants.

At this stage both coercion and encouragement may be used, depending on the circumstances. For example, some compulsion may be associated with overseeing the design and operation of tailings containment facilities. It is at this stage that proposals for expansion may result in industry being directed to rehabilitate old sites, or the reworking of old tailings may be proposed as a better "walk away" solution.

Some governments are using a mix of encouragement and coercion in their dealings with the mining industry by setting required limits or expected performance standards for a site and allowing the operator to determine how it will meet these requirements. This enables companies to perform their operations with the technology of their choice and to achieve their economic objectives through their own strategies rather than being limited by the conditions and processes set down by the government. More responsibility for the management of infrequent risks with high impacts is taken on by the company. Governments must have mechanisms to punish operators when their risk management strategies fail and incidents occur, to ensure this situation is effective in protecting the environment. Governments need to have mechanisms for compensation when environmental damage occurs, including the use of financial punishments.

Stage 3: Encourage better performance

Once significant progress has been made at Stages 1 and 2, it is feasible to encourage industry to go beyond required standards. At Stage 3, governments should focus on working with industry rather than on command. Most of the industry is already aiming at continuous improvement and this can be expected to achieve more than the coercive standards of a government, since industry has the necessary technical skills, management capacity and business incentive to improve its operations. Added to this, the mining industry operates worldwide in many different circumstances and with different levels of government standards. The initiatives of industry leaders, or the industry as a whole, towards sustainable development and continuous improvement is not bound or limited to the standards or legislation of any government, but rather by the industry's own expectations, and by how its members want their operations, reputation and performance to be perceived.

Governments can provide encouragement through a variety of economic instruments, such as load-based licenses or differential taxes on environmentally sound products. They can also promote concepts such as cleaner production, environmental management systems, or the use of mine improvement plans to encourage industry to continually improve beyond the required standards of a country.

If the use of authority, which was appropriate at the previous stages, is extended to this partnership stage then the system will fail. It is not appropriate to use coercive approaches to require industry to do better than regulations require, or for government to prescribe the means of achieving further improvements in performance. The role of government at this stage is to encourage better performance and to assist industry's improved performance by removing obstacles, encouraging innovation and improvement, and providing a more amenable atmosphere in which industry can function.

How should the mining industry respond?

While some parts of the mining industry have been slow to respond to the challenge, the best performers are showing the way to sustainable development. Three examples of actions by industry, some in conjunction with governments, are given in Box 3.

The most cost-effective environmental protection is obtained when the environment is considered at the start of a project. It is therefore somewhat surprising that, in the case of many mines, consideration, planning and management of mine rehabilitation, etc. still take place after the mine has already begun to operate. There are already too many mined-out sites in the world where insufficient planning, an unsatisfactory initial choice of equipment and inadequate rehabilitation provisions have left a legacy of environmental costs.

The industry response with regard to new and existing mines is nevertheless improving. Alcoa of Australia has been one of the leaders, with its rehabilitation of open-cut bauxite mines in the forest areas of Western Australia. Rehabilitation was planned for each 30-hectare pod before mining began. Mining equipment was chosen according to its suitability for use in rehabilitation work; mines were constructed so as to allow management of run-off water; mine floors were decompacted; topsoil and overburden were transferred from new pods to the previous ones for rehabilitation; and seed banks, nutrient reserves, seedling selection and plant disease were studied so that a juvenile forest compatible with the surroundings could be planted. Today a number of other mining operations have had similar successes.

There is now a significant body of "how to" literature, both national and international, on environmental protection in the mining industry. Among the most useful publications are: UNEP's Mine Rehabilitation for Environment and Health Protection: A Training Manual; the Australian Mineral and Energy Environment Foundation's

(AMEEF) Environmental Management in the Australian Minerals and Energy Industries: Principles and Practices; and the Australian Environmental Protection Agency's Best Practice in Environmental Management in Mining series. The latter is an expanding series that now includes more than 20 booklets written by the best industry practitioners in the Australian mining industry. The AMEEF is now responsible for the distribution of the booklets. Nine booklets have also been translated into other languages so far.

The most difficult environmental issue at mine sites is, perhaps, tailings disposal. This has been much debated since the dam failures near Rustenburg and Virginia in South Africa, the incidents at Marcopper in the Philippines and Omai in Guyana, the washout in heavy rainfall of the tailings dam at Ok Tedi in Papua New Guinea and, in January 2000, at Baia Mare in Romania. UNEP and the International Council on Metals and the Environment (ICME) have prepared a joint publication, "Case Studies on Tailings Management", which discusses the safe design, operation and rehabilitation of mines and tailings disposal operations and includes a number of case studies from around the world.

What standard is possible for a modern mine?

A modern mine can be a very good performer from the environmental point of view. Examples are regularly found in the national award schemes now prevalent in mining countries. In Australia, the Henty Gold Mine in Tasmania is leaving a very gentle footprint on the earth. There is much backfilling with cemented tailings, visual intrusion is insignificant, cyanide in wastewaters is well below 1ppm, and all mine process water is treated to drinking water standards with artificial wetland filters before discharge to streams. The environmental management plan, which included water quality monitoring and the collection of invertebrate data, was implemented before mining began on the site.

Many mines now have effective waste reduction and waste re-use programmes. Programmes to reduce emissions, energy and water use and the production of carbon dioxide are beginning to be initiated and are documented in company annual environmental reports.

Adequate information and experience are now available to allow operators to meet any reasonable expectation for mine site environmental performance. This is not to brush over the problems which may occur, but rather to indicate that if industry seeks it, the technology and management capacity does exist and is available to resolve most potential problems.

There has been a change in the balance of the relationship between industry and governments in terms of their interactions with the community in recent years. The structures of governments have been altering, they are now required to fulfill more commitments with less money and resources. Developers are now becoming more involved in managing the social and political acceptance of their own projects as a result of the changes to government structures worldwide. The situation where governments tax companies to provide the community with benefits as a result of the industry is being replaced. Today, in line with the theory of the triple bottom line, companies are providing direct benefits to those most affected by their operations. The environmental, economic and social impacts of the industry's operations on the community are being balanced by companies distributing social and economic benefits and ensuring environmental management in the areas where those who are most affected pay the economic and social costs for the existence and operation of their industry.

The mining industry can fairly claim to have made innovations in recent years that contribute to environmental protection but it needs to continue, taking further steps in order to fully embrace the concept of sustainable development and the triple bottom line. It can look to other industries and mining industry leaders, a few examples are given below:

- Environmental reports are already a component of formal environmental management systems such as ISO 14001. Company environmental reporting is being taken up by mining companies, following the lead of other industries. Company environmental reports cover policy, practice and performance. They disclose internal targets, which usually go beyond compliance, and discuss shortfalls as well as achievements. This type of report can be a powerful management tool if managed well, and especially if propaganda or "greenwash" is avoided. It can challenge and reinforce good performance, offer benchmarks across industry, and contribute to establishing trust within the community. This trust is a prerequisite for company-community interaction of sufficient quality to promote sustainable development.
- There are increasingly comprehensive codes of practice, drawn up by both companies and industry associations. Many of these codes of practice have evolved beyond dealing with compliance issues and may include audits and public disclosure. Codes of practice are evolving in the mining industry. The Australian Mineral Industry Code for Environmental Management was launched in 1996 by the Minerals Council of Australia. It was the industry's way of demonstrating that it would be publicly accountable for its environmental performance.

Box 3
Actions involving industry: some examples

Mine Environment Neutral Drainage (MEND) programme – Canada

Canadian mining companies are working with the Canadian government to "MEND" acidic drainage from mines. Industry and government jointly finance, sponsor and administer the Mine Environment Neutral Drainage (MEND) programme which develops and applies new technologies to prevent and control acidic drainage and to reduce the potential environmental liability due to it. It is estimated that the $17.5 million investment in the program over eight years has resulted in at least a $ 400 million reduction in liability due to acidic drainage from mines.

MEND has been described as an excellent model of how industry and government can work cooperatively to develop technologies that will advance environmental management in the mining industry. MEND 2000 is continuing work on projects and case studies, as well as developing links with the governments of other nations to co-ordinate research projects and information.

Mandate of ISO 14001 for all Ford Motor Company plants and suppliers around the globe

In 1998 Ford became the first automobile maker to have all its existing plants certified to ISO 14001. It is now requiring all of its suppliers with manufacturing facilities to be ISO 14001 certified by July 2003.

ISO 14001 is an environmental standard under which independent auditors evaluate the environmental processes and systems of a company. As part of Ford's implementation of ISO 14001 certification it has improved its global environmental management and performance. Within a year of its implementation of ISO 14001 Ford's Lima Plant:

- Reduced water consumption by nearly 200,000 gallons per day
- Eliminated production of boiler ash
- Increased the use of returnable packaging from 60 percent to 99 percent on its newest engine product.

Ford is requiring its suppliers to certify at least one manufacturing site to ISO 14001 by the end of 2001 and the remainder of manufacturing sites shipping products to Ford by July 2003. One quarter of Ford's top 150 suppliers already have ISO 14001 certification. In Europe, Ford is offering its suppliers ISO 14001 training to help them meet the company's goals.

Community and industry action – Western Australia

In Australia, action by the community and industry is helping protect the wedge-tailed eagle. The 50 metre road trains used at the Mount Keith Nickel Operations in Western Australia travel along the Kalgoorlie-Meekatharra Highway in areas where kangaroos abound. There can be as many as 100 kangaroo road kills a month. As the large wedge-tailed eagles feed on the dead animals and are slow to take flight when traffic approaches, several of them are killed each month. Through a combined community-company project, kangaroo carcasses are moved at least 20 metres from the road, allowing the eagles to feed in peace and safety.

The obligations of the Code include annual public reporting within two years of registration, the completion of an annual survey to assess progress in implementing the principles of the Code and auditing of survey results by an accredited auditor at least every three years. The industry itself made a commitment to review the Code every three years. A review was undertaken in 1999 and in February 2000 the new Code was released.

- The Responsible Care movement began in Canada and the United States, created by the chemical industry, it now exists worldwide. Its openness, and the involvement of the community and other stakeholders, are two particularly valuable features. UNEP's APELL programme, which has been adopted in many countries, draws on the experience of Responsible Care. Mining companies worldwide have benefited from adopting features such as those of Responsible Care into their own codes of practice.
- The importance of cleaner production is well understood in other industries and offers great opportunities to the mining industry. Cleaner production is a sustainable development approach which places the emphasis on not producing waste or pollution in the first place, rather than cleaning it up afterwards. Resources are used more efficiently through cleaner production and environmental benefits are often accompanied by health and safety benefits, cost reduction, and improved product marketability. Cleaner production can also reduce waste and waste disposal, as well as water, energy and raw material inputs, and provide a cost-effective approach to lowering air emissions, including greenhouse gases.

Conclusion

Society is better informed (and more concerned) than ever before about the unacceptable impacts of particular mines. Governments and mining companies alike are aware of these concerns and have produced mechanisms such as legislation, regulation, coercion, codes of practice and industry initiatives to provide the impetus for better environmental performance. Though far short of being universally available, the technical and management skills needed to protect the environment from the unacceptable impacts of mining do exist. Within the framework of effective regulatory and enforcement procedures, and augmented by the application of community relations skills learned from other industries in recent years, this expertise can be a foundation for the improved management of the social and environmental areas associated with the operation of the mining industry. Mining will make its proper contribution to sustainable development as this foundation is in put in place globally.

Notes

[1] The NEPA (National Environmental Protection Act), the enabling legislation for US EPA's formulation, was passed in 1969. It is often considered the first such act in the United States. In earlier public health and environmental protection laws, authority was given to various federal and state agencies.

[2] "It is unclear who coined the term (sustainable development), but by 1980 it was enshrined in the title of a key document for the eighties – *World Conservation Strategy: Living Resource Conservation for Sustainable Development*, published by the International Union for Conservation of Nature and Natural Resources, the World Wildlife Fund, and the United Nations Environment Programme. That Strategy's definition has stood the test of time well: "For development to be sustainable it must take account of social and ecological factors, as well as economic ones; of the living and non-living resource base; and of the long term as well as the short term advantages and disadvantages of alternative actions." Linda Starke, *Signs of Hope: Working Towards Our Common Future*, Oxford, 1990, p.9. ◆

◆◆◆◆◆

Abandoned mine sites: problems, issues and options

Introduction

One of the major outstanding environmental problems related to mining is that of abandoned mine sites, a legacy of centuries old practices, of inadequate, insufficient or non-existent mine closure. The potential costs of rehabilitation, the lack of clearly assigned (or assumed responsibility, the absence of criteria and standards of rehabilitation as well as other factors have delayed action by all parties – industry, governments and communities. Yet, land degradation from old mine operations is well known in almost all countries.

While many have seen these derelict sites, and there are many references in the literature, there have been few systematic surveys to quantify how many sites need attention. There has been even less work to quantify the nature of associated problems so as to priorize remediation efforts.

As a starting point for an international dialogue on this subject, UNEP has begun to collect information using national or regional inventories in addition to a global survey.

Abandoned mines sites

A review of work done to date indicates that there is no single definition of "abandoned mines". This raises several questions. First, what constitutes an abandoned site – is it a single shaft or an entire mining area? The second problem is that of ownership – some sites are 'owned' by someone other than the state but the state may be responsible for any clean-up because of the financial state of the company or individual. The third problem is what constitutes an environmental concern – many adits discharge a trickle of acid rock drainage but it is not worth doing anything about it?

The number of 'abandoned mines' world-wide, including every shaft, adit and alluvial working, will obviously run into millions. However, the fundamental question is how many sites actually constitute an environmental problem as an exaggerated figure may dissuade authorities from even seriously examining the problem.

Impacts from abandoned sites

In countries with a long mining history the magnitude of the impacts from past mining is often considerable, as environmental regulation of mining activities has in most cases only been introduced relatively recently. In the absence of a systematic international survey, some anecdotal evidence illustrates the situation.

- Large areas of dryland forest in Australia that were dug over in the goldrush in the 1860s have still not recovered. There is virtually no topsoil, and the land is covered by only sparse vegetation and stunted trees. It is estimated that more than 150 tonnes of mercury were lost from the diggings to the environment due to inefficient gold recovery processes . On the coast, fish still carry high

mercury levels from the contaminated sediments, and health authorities have counselled a limitation on consumption of fish caught locally.

- Acid drainage from the abandoned Wheal Jane and other mines in the UK has severely contaminated local streams. There is a considerable cost of water treatment of the ongoing drainage discharges and only a few treatment plants are operating.
- In Aberfan, the collapse of an abandoned dumpsite swept away a local school with the children and schoolteacher.
- A number of major minesites the US are listed as Superfund sites due to the extensive contamination from materials and exposed orebodies left behind.
- Abandoned pits and shafts over a large area of uncontrolled past alluvial mining in West African countries poses a serious public safety risk to local people and animals.

Abandoned tailings dams around the world are additional to abandoned mine sites and many of these could eventually pose environmental and safety problems (complete inventory of tailings dams exists and their number is certainly in the tens of thousands).

The impact of abandoned sites is significant including: altered landscape; unused pits and shafts; land no longer useable due to loss of soil, pH, or slope of land; abandoned tailings dumps; changes in groundwater regime; contaminated soils and aquatic sediments; subsidence; and changes in vegetation.

Results of such impacts include: loss of productive land;[1] loss or degradation of groundwater; pollution of surface water by sediment or salts; fish affected by contaminated sediments; changes in river regimes; air pollution from dust or toxic gases; risks of falls into shafts and pits; and landslides.

In addition to the obvious problems for the community, most of these situations present a considerable cost to the public authorities who are often expected to make the sites secure and prevent ongoing pollution. The public is increasingly demanding action and this visible legacy of the past is producing a growing community opposition to mining activities generally. Accordingly, the orphan sites problem continues to cast a shadow over all mining at a time when major operators are trying to improve the image of their sites and their company.

This can be compared with the situation at current operational mine sites where the need for rehabilitation is now taken for granted, and for which companies and governments have established legal, financial and technical procedures to ensure that mine sites are rehabilitated for another economic use after the operation ceases.

In fact, the case for rehabilitation of abandoned sites is the same as that for active mines. The difference is that the assignment of responsibilities is different. For abandoned sites it often lies with unidentifiable owners, and has thus led to non-action. However, the problems must be dealt with.

Accordingly, there is now a good case for starting a consideration of how to respond to the orphan sites issue at the international level:

- resource degradation is everybody's problem;
- it has a similar public rationale to rehabilitation of existing operational sites;
- it is inevitably a part of the wider debate on sustainable mineral development; and
- it is a part of the image problem for the entire industry, with consequences for the future 'licence to operate' syndrome.

Comparison with contaminated sites

The abandoned mine sites problem has the possibility to learn from governments' initiatives on chemically contaminated sites (some mine sites may actually fall into this category at the same time). The origins and history of these has a similar genesis in a past historical moment when consciousness of these problems were low, government regulation minimal or absent, and industry's consciousness of preventive action less than it is today. The result has been a large inventory of abandoned industrial sites, sometimes heavily contaminated.

The public pressure on chemicals risks has led many governments to take action, and contaminated sites programmes now have a well-documented history. There are perhaps, lessons to learn from these programmes, applying some of the methodologies that have evolved in a new context to orphan mine sites.

Contaminated sites programmes have led to the development of national approaches to assessment, preparation of inventories, prioritization, objective setting and developing action plans. These programmes could provide useful models for the mining industry.

Some governments have experimented with legal regimes to assign responsibility, or where none can be assigned, to impose a fiscal mechanism that levies the entire industry to pay for the clean-up. This so-called "superfund" mechanism has raised passions as well as money, and there is a view that resolution of problems through legal action results in a diversion of substantial amounts of capital away from remedial works. Conversely, alternative ways of raising the money have not been identified. However, it is time to address the issue in a creative and bold way.

Rehabilitation

Apart from any socio-economic aspects, the physical reclamation of an abandoned mine will include some or all of the following measures:

- permanent sealing of underground workings and all mine openings, prevention of water and gas leakage that could cause adverse impacts to neighbouring mines or to the environment;
- ensuring that any open pit or open cut features are stable and do not pose a risk to humans, animals or the environment;
- removal of all material and equipment lying at the surface;
- demolition of surface buildings and structures unless there is a productive use for them;
- all steps necessary to ensure the safety of tailings and slurry ponds, spoil heaps, waste dumps, stock piles and any other surface features that might pose an environmental or human hazard; and
- clearing areas formerly used for the mine surface facilities.

In general, the physical rehabilitation of a mine site will include:

- restoration of surface land including clean up of the premises, levelling the ground and revegetation;
- establish the nature of any water remaining in the open pit and treat if necessary;
- ensure that there is easy access to the water in the open pit to allow humans and people who might fall in a way out; or
- backfill the open pit;
- rehabilitation of waste dumps including surface drainage, redesign of slopes to an acceptable angle and revegetation;
- restoration of land affected by mining subsidence including refilling/levelling of the affected ground, wherever feasible and revegetation;
- rehabilitation of natural water courses directly affected by mining operations;
- collection and treatment of polluted mine water;
- treatment of surface soil wherever affected by mining activities; and
- monitoring the results for a specified period after the completion of remediation.

Some issues and trends currently affecting options in rehabilitation

We know that knowledge in the techniques of rehabilitating both operational and abandoned sites is extensive. So what is delaying remediation of this situation? It is rather the lack of clear legal and financing mechanisms that have retarded action.

More fundamentally, there is a lack of systematic inventories meaning that the problem is not sufficiently described for it to become politically important.

The experience with contaminated sites has also shown that a systematic approach on this issue is protracted, expensive to manage, and dependent on considerable technical expertise within the administration. Nevertheless, some initiatives, mostly in developed countries, is now occurring and there is enough momentum to start sharing of experience.

Governments have reacted more effectively in preventing current mines in turn from becoming "abandoned sites". For example, in Japan where a national survey found 5,500 abandoned mines, the government has taken a two-pronged approach to address the problem. Where the original owner exists, they remain responsible for the safety of the mine and the prevention of all pollution. Where the original owner cannot be found, or in the case of bankruptcy, the local and national governments tackle the problem jointly.[2] In other countries, some governments apply rehabilitation regulations and fiscal mechanisms to current operators. Some of these experiences, including the setting of performance targets, will be useful in addressing the orphan sites issue.

At the same time, the environmental approach by industry has become more comprehensive and mature, and presents some new options for co-operative approaches. Refinement of formal envi-

ronmental management systems and tools such as ISO 14000, EIA and environmental accounting have made environmental programmes a part of mainstream corporate management. There has also been a move towards more life-cycle approaches, with supply-chain management and extended producer responsibility now being taken more seriously by larger companies.

The recent acceptance by industry of the need for some voluntary measures and codes on environment to complement (or even to forestall) government regulation has resulted in action on a range of matters that have not so far been regulated. Consideration of these and other approaches needs to be applied to abandoned sites.

Industry is also becoming more involved in the global and national policy debates on sustainable development. Through various environmental codes, business charters and other commitments, companies are now more conscious of the need to address social issues, to adopt ethical positions, and to acknowledge that sustainable development is about values as much as about economics. Their commitment to sustainable mineral development now needs to be practically applied.

Conclusion

Although there have been few attempts at quantification, it is generally understood that the issue of abandoned or 'orphan' mine sites is a major unresolved environmental and social problem for the industry. Potential impacts include a range of health and safety problems, and extensive economic impacts due to resource degradation and water pollution. So far there are only a small number of systematic programmes to deal with the issue. However, experience with similar problems in contaminated industrial sites and with rehabilitation of operational mines has provided sufficient elements to allow for a serious start on the orphan sites problem.

Notes

[1] In China, mining waste is stockpiled on 2 million hectares of desperately needed land.

[2] Information from 2 papers presented by Metal Mining Agency of Japan at the 3rd Asia Pacific Training Workshop on Hazardous Waste Management on Mining, Beijing, China, September 2000.

◆

◆◆◆◆◆

Training small scale miners: the video project

Grant Mitchell, Senior Policy Analyst, Minerals and Energy Policy Centre, P.O. Box 395, Wits, 2050, South Africa

Introduction

Following on from the recommendations of a White Paper on a new mineral policy, South Africa's National Steering Committee of Service Providers to the Small Scale Mining Sector (NSC), was tasked with developing the sector. The Capacity Building Sub Committee in particular was to be responsible for production of a training course for small scale miners.

Developing a policy proposal is one thing, but it is quite another matter to translate such proposals into tangible results. The acid test for the NSC is when its dozen pilot projects become fully-fledged self-sustaining mining operations. Developing the capacity of the small scale miners manning these operations is of critical importance in this process.

The mining hierarchy in South Africa is well documented. A few large and powerful companies have for the past one hundred years held a monopoly on mineral rights, access to finance and technological expertise. Small scale miners, in contrast, generally come from the most economically marginalized sectors of society – the "poorest of the poor". Educational levels are extremely low. In fact most small scale or artisinal miners are illiterate and have a poor understanding of the new legislative framework despite the efforts of KWAGGA to disseminate the contents of the White Paper to communities affected by mining. There is also a poorly developed understanding of technology deployed and of business planning and marketing.

Training for empowerment

Clearly training is a vital component in assisting small scale miners in advancing from subsistence levels to profitable operations. The challenge is to develop a tailor-made course that can propel small scale miners from pick and shovel operations towards mechanized ones. This also means that what was previously an unregulated activity may become legitimate. The task facing the Capacity Building Sub Committee is to package the information in such a way that core competencies can be acquired and skills transferred.

In the light of the above, it was decided that the most cost-effective form of training would be to develop a video production explaining in simple terms the key requirements of the legislative and regulatory environment, as well as other basic skills required for mining, such as business planning. Without such an understanding small scale mining will be an environmental disaster area in South Africa, and will also act as a conduit for unscrupulous operators who will use small scale operators for their own, often illegal, ends.

Language and literacy is a huge issue confronting any training effort. For this reason it was decided to use the medium of video as the principal teaching method, supplemented by facilitators who will negotiate content and direct the discussions. It is also proposed to translate the videos into all the languages spoken in South Africa.

Course content and training strategy

The course content will cover all the key pieces of legislation relevant to any existing or prospective miner. For example, health and safety legislation, mineral rights and permitting, labour legislation and environmental standards will be presented. There will also be a specific course on how to develop a small business venture and all that this entails: budgeting, planning, taxation, etc.

In terms of training strategy, it is proposed that the course, which comes complete with a trainers guide, should be presented initially to the 12 small scale mining projects which are currently being driven by the NSC. Trainers will be identified from each of these projects and given a "train the trainers" course. It is also hoped that the videos can be distributed to a wider group and even used as source material, i.e. in schools and Technikons.

Conclusions

The video-training project is a first step in using education as a tool to both empower and regulate the sector. This is an important starting point but must be viewed as just that – a starting point. Running a mining operation, even a small one, is a complex business and one that requires on-site training as well as, most importantly, mentorship. What is critical for the success of this sector is to identify suitably qualified and experienced people to provide the project management expertise.

◆

Rehabilitation measures: water management

	Rehabilitation Objectives	Control Technologies
Physical Stability Issues		
◆ Water dams - Stability - Erosion - Overtopping - Intakes/ decant - Towers	◆ Ensure long-term stability ◆ Protect erodible slopes ◆ Ensure no overtopping ◆ Seal pipes	◆ Maintain embankment indefinitely ◆ Breach dam ◆ Maintain operating spillway in durable rock ◆ Plug intakes with concrete, plug decants and remove towers ◆ Monitor
◆ Ditches - Overtopping - Erosion	◆ Adequate flood capacity ◆ Prevent blockage ◆ Prevent erosion	◆ Design for extreme events ◆ Construct from materials suitable for long-term stability ◆ Riprap protection ◆ Provide for long-term maintenance ◆ Monitor
◆ Storage tanks - Stability	◆ Remove	◆ Drain, remove or knock down, fill, & cover ◆ Monitor
◆ Pipelines - Collapse - Obstruction	◆ Remove surface and large shallow pipes	◆ Remove all surface and large shallow pipes ◆ Plug those pipes at depth ◆ Monitor
◆ Culverts - Blockage - Collapse	◆ Ensure maintenance free passage of water under design flood conditions	◆ Remove and breach if not required ◆ Upgrade to pass design flood ◆ Provide for long-term maintenance ◆ Monitor
Chemical Stability Issues		
◆ Contaminated reservoirs	◆ Meet water quality objectives by: 1. Control reactions 2. Control migration 3. Collect and treat	◆ Drain, treat and discharge ◆ Strip and dispose of contaminated soils in tailings dam or approved location ◆ Breach dam ◆ Establish vegetation ◆ Treat indefinitely, if necessary ◆ Monitor
Land Use Issues		
◆ Dams - Interruption of drainage	◆ Restore drainage patterns ◆ Determine if alternative use exists	◆ Breach and restore to erosion resistant drainage ◆ Stabilise to maintain dam
◆ Reservoirs - Productivity of land - Potential water supply	◆ Return to appropriate alternative use	◆ Maintain dam ◆ Drain and establish vegetation
◆ Ditches	◆ Restore drainage patterns	◆ Grade to restore natural drainage ◆ Establish vegetation

Rehabilitation measures: tailings impoundment

	Rehabilitation Objectives	Control Technologies
Physical Stability Issues		
◆ Tailings - Dust - Water erosion	◆ Control dust migration ◆ Control tailings erosion	◆ Establish erosion resistant covers of vegetation soil, riprap or water ◆ Monitor
◆ Dams - Deep seated or overall - Slope failure - Surface slump - Erosion	◆ Factor of safety >1.5 for static conditions ◆ Erosion resistant overtopping protection ◆ Restrict access	◆ Appropriate site selection and dam design (P) ◆ Where necessary, stabilise embankments by constructing toe berm to flatten overall slope ◆ Riprap or vegetation cover to control erosion ◆ Increase freeboard and/or upgrade spillway to prevent overtopping ◆ Ditch/ berm/ fence to prevent erosion by motorised vehicles
◆ Weathering ◆ Destruction of permanent - Structures - Spillways - Decant towers & pipes ◆ Drainage disruption	◆ Remove or establish long-term stability ◆ Integrate with local drainage	◆ Remove or plug/ backfill structures ◆ Diversions and spillways designed for long-term stability ◆ Plug/ seal decant lines through embankments ◆ Define and provide for long-term monitoring and maintenance ◆ Avoid ongoing operation where possible
Chemical Stability Issues		
◆ Tailings and pore water - Acid drainage - Leaching - Mill reagents	◆ Meet water quality objectives by: 1. Control reactions 2. Control migration 3. Collect and treat	◆ Implement permanent control measures ◆ Flood to control reactions ◆ Pre-treatment-removal of deleterious material for controlled disposal elsewhere or blending with alkali material to mitigate acid drainage (P) ◆ Cover to control acid reactions and/or migration using inert material or bog ◆ Ditch to divert run-off ◆ Collect and treat – active treatment to be avoided where possible
◆ Dams, structures	◆ Meet water quality objectives by: 1. Control reactions 2. Control migration 3. Collect and treat	◆ Do not construct with materials which are potential acid producers or are leachable ◆ Decontaminate and/or remove acid generating or leaching materials
Land Use Issues		
◆ Productivity of land ◆ Visual impacts	◆ Return to appropriate land use	◆ Rehabilitate by one or more of the following means: - Flood, contour, cover, establish vegetation, wetland

(P) option to be implemented at approved pre-mine stage

Environmental and toxicity issues

Biodégradation/persistance et bioaccumulation/ biomagnification des métaux et des composés métalliques

Résumé

L'atelier technique Canada/Union Européenne sur la biodégradation/persistance et la bioaccumulation/biomagnification des métaux et des composés métalliques a pris en considération les aspects scientifiques de deux des critères – biodégradation/persistance et bioaccumulation/biomagnification – pour déterminer les dangers et évaluer les risques. Les concepts sont en général acceptés à l'échelle internationale quand ils s'appliquent aux composés organiques synthétiques. Toutefois, l'applicabilité des concepts à des composés métalliques inorganiques (c'est-à-dire à l'exclusion des composés organométalliques) a soulevé des problèmes et c'est sur cet aspect que se sont penchés les participants à l'atelier.

Abstract

The Canada/ European Union Technical Workshop on Biodegradation/ Persistence and Bioaccumulation/ Biomagnification of Metals and Metal Compounds considered the scientific aspects of two of the criteria – biodegradation/ persistence and bioaccumulation/ biomagnification – for hazard identification and risk assessments. The concepts have broad international acceptance when applied to synthetic organic compounds. However, problems have arisen with their applicability to inorganic metal compounds (e.g. excluding organometallic compounds), and this was the main focus of the workshop.

Resumen

El Taller Técnico de la Unión Europea/Canadá sobre Persistencia y Bioacumulación/ Biomagnificación de Metales y Metales Compuestos consideró los aspectos científicos de dos de los criterios, biodegradación/persistencia y bioacumulación/biomagnificación, para identificación de peligros y evaluación de riesgos. Los conceptos tienen amplia aceptación internacional cuando se aplican a compuestos orgánicos sintéticos. Sin embargo, han surgido problemas con su aplicabilidad a compuestos metálicos inorgánicos (por ejemplo a la exclusión de compuestos organometálicos) y este fue el tema principal del taller.

L'une des préoccupations principale que soulève l'identification des risques environnementaux potentiels que pose un produit chimique est l'estimation de l'exposition à court et à long terme des espèces toxiques biodisponibles. Comme il a été convenu que les métaux élémentaires et composés métalliques inorganiques en phase solide ne sont pas assimilés par des organismes, on s'est intéressé à la libération dans l'environnement d'espèces métalliques biodisponibles provenant de tels composés inorganiques.

Il a été convenu que la biodégradation ne peut constituer un critère approprié pour l'évaluation des risques environnementaux que comportent les substances inorganiques et que les lignes directrices pour les essais de biodégradabilité immédiate de l'Organisation de coopération et de développement économiques (OCDE) ne devraient pas être utilisées pour le contrôle de telles substances. La "dégradation" et la "transformation" (incluant la dissolution) des composés inorganiques ont été proposées en tant que critères plus appropriés.

La détermination des caractéristiques de solubilité ou de transformation, y compris la cinétique de dissolution ou la vitesse de transformation d'un métal ou d'un composé métallique inorganique a été recommandée comme première étape pour évaluer l'exposition environnementale potentielle à court et à long terme des ions métalliques biodisponibles. Les membres de l'atelier ont recommandé, comme point prioritaire, qu'une méthode normalisée soit élaborée pour déterminer les caractéristiques de solubilité des métaux et composés inorganiques modérément solubles, dans le but d'identifier le dangers qu'ils posent.

La deuxième étape dans l'estimation de la concentration des ions métalliques biodisponibles concerne les transformations qui peuvent se produire quand ils sont retirés du milieu aquatique (par example par précipitation, oxydation, réduction, absorption et enfouissement). Des modèles pour prédire la concentration d'ions métalliques dans des conditions environnementales (aquatiques) connues ou présumées sont disponibles mais il a été convenu que d'autres travaux devront être effectués pour les valider. Les participants ont également convenu que dans la plupart des cas, dans des conditions environnementales naturelles, les transformations des espèces solubles tendaient à diminuer leur concentration (c'est-à-dire effectivement éliminer les ions métalliques résultant de la transformation du métal de base ou composé inorganique).

La persistance des substances organiques synthétiques signifie qu'elles peuvent exister dans l'environnement au moins partiellement sous forme biodisponible pour de longues périodes, influençant ainsi la durée de l'exposition potentielle. D'autre part, de nombreux composés inorganiques ont tendance à être indéfiniment persistants au regard des échelles de temps des substances organiques. De plus, ce sont les ions métalliques biodisponibles solubles résultant de la transformation qui sont actifs biologiquement comparativement aux substances organiques où c'est la substance persistante qui a habituellement une importance toxicologique. Par conséquent, quand le terme " persistance " est appliqué aux substances inorganiques, sa connotation est bien différente de celle qu'il a quand il est utilisé comme critère de risque pour les substances organiques.

Bioaccumulation et biomagnification

Les métaux élémentaires et composés métal-

liques inorganiques en phase solide ne sont pas, en général, biodisponibles comme tels, et, par conséquent, la bioaccumulation de composés métalliques ne constitue pas un paramètre utile pour l'identification des risques qu'ils comportent. Toutefois, ce sont les ions métalliques solubles constituants qui sont bioabsorbés par voie de divers mécanismes et processus qui, effectivement, contrôlent la bioaccumulation des ions métalliques par les organismes. D'autre part, la bioaccumulation des composés organiques se produit par diffusion passive et liposolubilité et un essai pour mesurer le coefficient de partage octanol/eau est souvent le moyen utilisé pour prédire la bioaccumulation potentielle d'un composé organique. En raison des mécanismes complexes qui contrôlent la bioaccumulation des ions métallique, il n'existe actuellement aucun essai pour prévoir la bioaccumulation potentielle d'ions métalliques solubles.

La bioaccumulation d'un ion métallique par un organisme ne peut être mesurée que par une analyse directe des tissus et par la comparaison des concentrations avec celles de l'eau ou d'un autre milieu d'exposition. Les facteurs de bioconcentration et de bioaccumulation résultants dépendent du métal et de l'organisme considérés et sont, par conséquent, utiles pour évaluer les risques spécifiques mais non pour prédire, en général, les risques environnementaux. Dans l'interprétation de ces données, reconnaître que divers organismes exigent de petites quantités de certains métaux essentiels constitue un facteur de complication. De plus, un des mécanismes de contrôle susmentionné permet à certains organismes de contrôler l'absorption et l'expulsion des métaux essentiels par homéostasie qui résulte dans la dépendance des facteurs de bioconcentration sur les concentrations relatives, internes et externes, de métaux. Un organisme peut absorber des quantités de métaux essentiels et non essentiels qui peuvent s'avérer toxiques pour lui-même ou pour un prédateur, c'est-à-dire un autre organisme qui l'absorbe. On devrait tenir compte de cette bioaccumulation spécifique de métaux et de " l'empoisonnement secondaire " possible dans l'évaluation des risques.

En raison des facteurs complexes de contrôle et du fait que la bioaccumulation des ions métalliques dépend des organismes considérés, les membres de l'atelier sont d'avis que la biomagnification des ions métalliques à des niveaux plus élevés du réseau alimentaire écologique ne constitue pas un critère général utile pour l'identification des risques que posent les composés métalliques inorganiques ou les ions métalliques composants.

◆

◆◆◆◆◆

Future challenges facing the mining industry: an environmental health perspective

Michael R. Moore and Barry N. Noller, NHMRC National Research Centre for Environmental Toxicology, 39 Kessels Road, Coopers Plains, Qld 4108, Australia

Abstract

Mining and mineral processing must become "greener" and be more aware of community needs and expectations. Environmental health considerations must be taken into account to ensure that a proper balance exists in total exposure where both human health and the environment are concerned. This means that risk-based evaluations will become a common platform for measurement of health impacts. Better measures of exposures and doses are needed, taking account of factors such as bioavailability. Risk assessment and communication must be less dependent on modelling strategies and must be made to better reflect reality, by means of on-site testing challenging the assumptions behind models.

Résumé

L'exploitation minière et le traitement des minéraux doivent devenir plus "écologiques" et prendre davantage conscience des besoins et des attentes de la population. La prise en considération de la salubrité de l'environnement est nécessaire pour assurer un juste équilibre entre les risques globaux pour la santé de l'homme et pour l'environnement. Cela signifie que les évaluations basées sur les risques sont appelées à devenir une plate-forme commune pour mesurer les impacts sur la santé. De meilleures mesures de l'exposition et des dosages sont nécessaires et doivent tenir compte de facteurs tels que la biodisponibilité. L'évaluation et l'information sur les risques doivent s'affranchir des stratégies de modélisation et devenir plus conscientes de la réalité par des tests sur le terrain destinés à remettre en question les hypothèses sur lesquelles reposent les modèles.

Resumen

La minería y el procesamiento de minerales deben ser más cuidadosos del medio ambiente y más conscientes de las necesidades y expectativas de la comunidad. Es necesario tener en cuenta la salud ambiental para asegurar que exista un equilibrio adecuado entre exposición total y salud humana y ambiental. Esto significa que las evaluaciones basadas en los riesgos constituirán una plataforma común para medir los impactos sobre la salud. Se requieren mejores medidas de exposición y dosis que tomen en cuenta factores tales como la biodisponibilidad. La evaluación de riesgos y la comunicación deben depender menos de las estrategias de modelado y tener mayor conciencia de la realidad mediante testeos en campo para desafiar las hipótesis de los modelos.

Introduction

The future of mining depends on the industry's capacity to maintain the balance between profitability and preservation of the environment. In particular the minimization of future liabilities associated with mining wastes needs to be better addressed at the project design stage and during the course of mining prior to rehabilitation. Human capital also needs to be conserved, both on-site and as a consequence of potential environmental health impacts of mining operations. This requires assessment of risk at all stages to ensure that impacts on the environment and on humans are always understood. Appropriate monitoring techniques are required to assess the adequacy of rehabilitation.

This article considers key issues associated with such future sustainable mining practices and the significance of key aspects of the polluting process.

Current mining issues

As ore bodies at the surface of the earth become depleted so the search goes on for deeper and more remote locations for future mineral resources. In the context of modern mining practice, sustainability of mining equates with zero or limited environmental impact after mining. Minimization of impacts will carry with it the probability of minimal environmental health impacts as well as diminished occupational health consequences. No significant liability should be carried forward as a result of legacies of improper mine

use and close-out. As a consequence, there is now great pressure to improve the whole of mining profitability whilst meeting the goals of sustainability.

Mine tailings and other wastes have another key role: last years garbage may, and often does, become this year's resource. The availability of improved extraction techniques is making the economic viability of re-extraction of elements such as gold and cobalt from old tailings acceptable. Evidence of this is seen in the manner in which many mining operations have funded their gold extraction operations through processing of old tailings following the development of the "carbon in leach" process.

Current mineral extraction processes

The key step following mining of a resource is mineral extraction. This step separates and purifies valuable items in ore and usually involves the use of reagents and/or physical separation steps. Ingenious separation steps have been devised and, in many cases (such as cyanide for gold extraction), have been used for a hundred years or more.

Following extraction, the ground rock mass and reagents in tailings become one of mining's significant wastes. Proper containment is needed to retain tailings and prevent dispersion, particularly above ground. Dewatering of tailings is necessary to make tailings into a rock-like mass. Dry tailings management, coupled with stabilization techniques such as cementization, is the preferred method. Engineering of tailing dam walls is the key step in preventing dispersion of above ground tailings. There is also a need for appropriate long-term management of such wastes through revegetation and landscaping.

It is, however, the failures in management of tailings dams that have given mining a bad name, most recently at Baia Mare, in Romania. This incident was handled poorly and resulted in considerable bad press and bad community perception of the project in question and of mining as a whole, especially the Australian sector. In contrast, the loss of cyanide during a flight to Tolokuma gold mine in Papua New Guinea was handled extremely well by the mining company which paid great attention to immediate cleanup and the sensitivity of community relations. However, both incidents point to the need for much better risk management by the industry. They also show that those involved in management of ethical issues need to apply the same precautions in developing communities as they would be required to in the developed world. (For more information on this subject, readers may like to consult the following website: http://pidp.ewc.hawaii.edu/PIReport/2000/June/06-02-06.htm).

Although ground rock is generally innocuous, the presence of reagents and other constituents of mineral origin, such as sulphides which become acidic following exposure to air and water oxidation, becomes an enhanced hazard through the leaching of other metals from the rock matrix with a potential to cause off-site ecological impacts. Soluble reagents can also be dispersed. It is the collective property of tailings, together with their fine size enabling dispersion in flowing water courses, which has given rise to ecological and human disasters.

Waste rock management is also a key issue, particularly when associated with sulphidic mineralization. Acid mine drainage from oxidation of sulphides can give rise to significant off-site impacts in aquatic ecosystems when associated with the release of toxic heavy metals and metalloids which may be present in the waste rock.

Site water management

All mining projects in high rainfall areas, and particularly those in the tropics where rainfall intensities are higher, need a robust water management plan. Whilst site planning can minimize catchment collection and can reduce the volumes of water to be discharged, it is becoming obvious that future mining projects will need to find other innovative ways of reducing stored water volumes. Such techniques will need to involve water purification using energy minimisation techniques such as solar assisted evaporation, and will need to incorporate water recycling.

The goal of "nil-release" will be difficult to achieve as a stand-alone procedure. It will need to accompany the application of techniques which keep the contaminants out of water, such as those described below. Thus a focus on integrated site management (including impacted areas off-site) is an important consideration. Mined areas may need to be "covered" to prevent contact of water with exposed minerals and waste rocks, and the build up of waste water which generally occurs following storms.

Precise mineral resource extraction

There is also a need for greater sophistication in resource recovery. There will be an increasing need to better define resource material from waste. This relates specifically to the accuracy of measuring of the resource grade in relation to the appropriate cut off grade. For example, gold in sulphide rock is delineated on the basis of grade. When sulphur concentration is high in waste rock the reject material has to be handled carefully to minimize future environmental liability arising from acid generation. The current approach is to map both gold grade and sulphur grades in both ore bodies and haloes. The acid-generating waste rock is then placed in repositories constructed ahead of material removal and not closed off until completely removed from the mining activity. Such procedures need to be streamlined so that the impact of waste is minimized. The utilization of back-filling techniques, including open pits with cementized material, should be encouraged.

Selective handling of mineral extraction reagents

A range of specific chemical reagents is used in mineral extraction processes, with a spectrum extending from full reagent recovery (e.g. solvent extraction of nickel or uranium) to transfer to tailings storage (e.g. cyanide for gold and sodium hydroxide for bauxite/aluminium) and even complete destruction before storage or discharge (e.g. cyanide). Complete destruction removes the potential for reuse of a valuable commodity and is usually applied to minimize effects on stock, aquatic life and human health. It is therefore appropriate to consider the incorporation of *stand alone* plant technology which will enable reagents such as cyanide, sodium hydroxide, acids and surface active agents to be recovered and reused. It is desirable that such processing strategies, together with water recycling, be undertaken in "closed loop" systems which recover reagents and only transfer minimum quantities to tailings.

Application of "green" chemistry to mineral extraction

Green chemistry builds on the concepts of cleaner production and seeks to develop chemically-based extraction and reaction procedures which use environmentally friendly reagents and solvents. For example the shift from solvent-based reagents to water-based ones leads to wastes which can be handled in the aqueous phase and therefore elimination of organic solvent waste. The principle is that the reagents in question lead to a waste which becomes more environmentally acceptable. This strategy fits squarely with the proposal to recycle reagents. In the context of green chemistry, it means the design and selection of mineral extraction procedures that are more environmentally friendly and lend themselves to recycling.

Role of bioavailability

The bioavailability of chemical species is at the heart of risk assessment for the impacts of mining wastes. Bioavailability is defined as the fraction of chemical forms, called the biologically-available (or bioavailable) fraction, which can be taken in by organisms (plants, animals and humans) and is thus potentially capable of harming those organisms. Dissolved free metal ions are probably the most bioavailable form of metals and are usually only a very small fraction of the metals in the environment. Total metal concentrations are therefore not an indicator of potential effects unless the concentration of biologically available metal is known.

Total element concentrations are rarely sufficient to describe environmental processes. The determination of chemical species which may be toxic is a more complex task than the determination of total elemental concentrations. Currently, analysis of chemical species that may be bioavailable is directed towards the identification and quantification of species in isolated samples. Solubility is *not* bioavailability, as more subtle factors are involved including the complex chemistry of interaction between the diverse elemental composition of minerals and the total consequences of exposure to specific elements like mercury and lead.

Understanding the role chemical species play in bioavailability is necessary to understand:

- Abundance and distribution
- Accumulation by organisms
- Toxicity to terrestrial and aquatic organisms

The need for information about bioavailability

in the context of mining as a sustainable practice requires generating of data that indicate when exposure following dispersion or transport is no longer safe. Clearly, this need applies to tailings and other mining wastes that have been rehabilitated.

Modelling is not going to give all the answers. The need is for real-time experiments that deal with the challenge of bioavailability in humans and animals. This should accord with the reality test: do exposed humans show evidence of dose?

In the future, it will be more important to design monitoring which takes account of the assessment of bioavailability as a basis for assessment for closeout of a mining project. Hence the need to take on board this concept at the outset of a project and to make assessments as the project develops. Realistic and experimentally based criteria need to be developed on a site-specific basis, taking into account final future land use. For example, the risk associated with future land use involving cattle and pastoral activity can be assessed by designing experiments and monitoring techniques that show the bioavailability of mining waste to cattle, via feeding trials and on site experiments.

Environmental health expectations

A key issue in dealing adequately with the perception of risk of environmental health impacts lies in a greater degree of involvement in risk communication by industry. In many cases the perceptions of ill-health associated with modern mining practice are unjustified and are largely founded on a poor appreciation of the relationships between hazard, exposure and dose. A key issue here is the role of bioavailability, as described. The mere presence of toxic elements in mineralogical material does not, of necessity, mean that there will be exposure of humans. Even when exposure occurs the consequences are determined by the dose, which is usually wholly dependent on bioavailability. Since this is a perceptual process, factors such as aesthetics and noise abatement which have previously been given scant attention by the industry can have a disproportionate influence or the perception of risk by the public. In these circumstances the rehabilitation of mine sites becomes extremely important, not only because it diminishes the inevitable environmental damage associated with ore extraction, but also because it engenders a perception of care for the environment and, by association, care for other factors such as environmental health and occupational health.

In a risk based process, it is also important to note that the models used to assess environmental health risk are subject to considerable levels of change at the present time. A key issue at present is the level of conservatism that can be applied in carrying out risk assessment. Although an appropriate level of conservatism is important for public policy, models that apply excessive conservatism in risk assessment may cause major distortions in the results of the analysis. This is particularly true when there are multiple layers of conservative assumptions and where the compounding effect may lead to over-caution. Independent of the obvious economic consequences of an excess of caution, there are also the perceptual consequences of this, associated with excessive levels of anxiety within a community in which the perceived risk is in fact much greater than the actual one. The key issue in such circumstances is provision of accurate data to drive the risk assessment and, in particular, accurate data for both dose-response assessment and exposure assessment which will better inform the risk management process.

Community role and expectations

The community has a clear role in indicating whether or not the activities of a mining project are acceptable in its eyes. The incidence of community outrage from indigenous peoples is increasing, but it can be overcome by involving them at a sufficiently early stage in project development. It is important to identify community views on future land use and to have members of the community understand that their views are met by careful, responsible management. The role of risk assessment is clearly important in demonstrating to local communities that the proposed environmental management procedures for mining project will actually work.

An important component of risk assessment with respect to the community is risk communication, which requires presentation in clear and plain language. This is an important point where community outrage can be diffused by the mining industry.

For the mining industry, it is important to recognize that the general public perceives risk as multi-dimensional and inadequately described by numerical values. The public will therefore judge risk according to characteristics and context, and not by numbers. A major issue here is that one has to employ the best forms of risk communication. Good risk communication results in a high level of agreement between the affected parties. It requires that those involved carry out a genuine process, conducted with the communities' interests in mind. The traditional mining industry has been poor at doing this and has therefore suffered from the forms of public outrage associated with inadequate communication. Accordingly, there is a sequence of key principles in environmental health risk assessment associated with mining which reflects the necessity to adequately protect public health and to protect the environment and, in seeking this endpoint, to do so by putting responsibilities of this nature before other considerations. The way in which risk assessment is carried out should be transparent. There should be no hidden default values or assumptions so that the conclusions drawn on the basis of available evidence are readily understood. Finally, in the process of protection of public health and of protection of the environment, appropriate degrees of conservatism must be adopted to guard against uncertainties which are invariably present as a consequence of data limitation.

Notes:

The response of one part of the international mining sector in Australia is informative. It is suggested that readers look at the status of mining and environmental control in Australia by consulting the proceedings of the recent 4th International & 25th National Mineral Council of Australian Environmental Workshop entitled "Environment Everyone's Business: Learning through a Business Perspective", held in Perth, Western Australia on 29 October-2 November 2000. The proceedings are published by the Minerals Council of Australia which can be contacted at the following website: www.minerals.org.au or by e-mail at nedra.burns@minerals.org.au. Further details regarding the Australian mining industry can be found on the web page of the Australian Minerals &Energy Environment Foundation (AMEEF): www.ameef.com.au. ◆

on their budgets find it difficult to locate the funds necessary to upgrade skills and acquire the analytical and monitoring facilities necessary to apply such instruments effectively.

...but problems remain and scarce resources for environmental protection have to be applied where they are most effective

The concept of using trade measures to influence environmental policies or achieve at least some internalization of environmental costs is attractive to many but has proved difficult to translate into practice. The debate about trade and the environment reflects legitimate concerns about the environmental consequences of the ongoing globalization process. However, trade measures are blunt instruments and their application with a view to promoting better environmental management may give rise to new and worse problems than the ones initially targeted. Moreover, it should be realized that developing countries could suffer unintended and unnecessary negative impacts on their trade if such measures were to be applied. Since international treaties are cumbersome to negotiate and difficult to enforce, it may be easier to counter unwanted consequences of globalization through public opinion pressure, directed at those governments and enterprises that appear to disregard environmental impacts of their policies and actions.

As far as minerals and metals are concerned, the main item on the environmental trade agenda now appears to be efforts to restrict the transport or processing of certain materials that are deemed to be hazardous. The Basel Convention is the best known example of this trend, but proposals in the same vein have been made in a number of international fora. Proposals for such restrictions have caused considerable concern in industry circles since they appear to disregard the costs of restrictions, which would have to be borne by industry. Other serious concerns include the extent to which the proposed restrictions are based on adequate risk assessments and the limitations to international trade that would be imposed as a result, with the attendant economic inefficiencies. Most importantly, it can be questioned whether those types of restrictions, given their cost in terms both of the creation of artificial scarcities and the need for institutional frameworks charged with monitoring and enforcement, constitute a cost-effective way of reducing environmental damage.

One of the largest, if not the largest environmental challenge facing the international mining community today is posed by the many closed mine sites in developing countries and countries in transition which constitute major hazards for the environment and where it is not possible to use proceeds from production to finance a clean-up. Many of the sites may result in considerable environmental damage if left unattended. While the need to rehabilitate these "orphan sites" is widely recognized, it is also clear that the governments of the countries concerned – unlike governments in developed countries where this problem is being dealt with – lack the financial means to do so and that no other realistic solutions to the financing problem have been found. In fact, the dimensions of the financing problem are not even well known, possibly because it is feared that any effort to arrive at a cost estimate might lead to resignation rather than action. So far, progress with clean-up has been piecemeal and improvised, and there is no assurance that the most serious situations in terms of human health, ecological impact or economic importance have been addressed on a priority basis. The problem clearly has to be addressed in the context of abandoned hazardous sites in general, and it is to be hoped that institutional and financial solutions can be found that permit an elimination of these continuing dangers to the lives and health of local populations. It is difficult to see that any concrete results could be achieved through international legislation. The only example of a legal approach being used to deal with the problem of "orphan sites", the "Super Fund" in the United States, has, according to all observers, entailed very time consuming negotiations. Doubts have also been voiced with regard to its effectiveness and the equity of the outcomes. Thus, governments and industry have to work together to determine the size of the problem and identify realistic rehabilitation methods, financing solutions and a time schedule for rehabilitation. The time schedule can be long, what is important is to begin to approach the problem in a serious manner. While the industry cannot be held collectively responsible for the actions of some individual companies, it does have the knowledge about the methods that could be used to deal with the "orphan sites" and it should be concerned about the public impact of the problem. Therefore, the industry may consider it to be in its own interest to be a part of the solution to the problem of orphan sites, rather than fostering the impression that it is only a part of the problem.

A major change – the full implications of which are difficult to sort out however – would be the internalization of the environmental and resource costs of energy production. While complete "full cost pricing" of energy is neither likely to be introduced rapidly, nor in the very near future, it appears certain that steps in this direction will be taken as the unsustainability of evident or hidden subsidies to energy production and consumption in the long term becomes more evident. The mining and metals industry would be expected to be one of the industries most affected by such a change, given its intensive use of energy in all forms. Even partial steps in this direction could raise the price of metals and reduce their competitiveness vis-à-vis other materials which might use less energy. However, several of the substitutes are also energy-intensive and this might serve to diminish the impact. In addition, recycled metals would be likely to become more competitive, since their production tends to be less energy-intensive than the production of primary metals. Increased recycling rates would therefore be a probable outcome, which would be modified, however, by limits to the economic availability of scrap. For metals that have exhibited a fast growth in consumption in recent years and/or are used in long-lived products, the possible increase in recycling rates may also be quite modest due to limited physical availability of scrap. While the full effects of changes to energy prices are difficult to assess and are likely to vary significantly from one mineral raw material to another, it is clear that they will have effects on the way that minerals and metals are produced and used and, by implication, on environmental management in mining.

In conclusion, there are reasons to be optimistic about the prospects of reducing the negative environmental impacts of mining. However, in a world characterized by increasingly tight government budgets, it is important that all those who take an interest in good environmental management of mining help ensure that the scarce resources available for this purpose are used in as cost-effective a manner as possible and that the main part of the resources are devoted to the problems that have the largest potential or actual impact on the health and safety of people.

Notes

[1] The views expressed are those of the author and do not necessarily represent the views of the UNCTAD secretariat

[2] Over the period 1930-1980, only 0.25 per cent of the total land area of the United States was used for surface mining, disposal of wastes from surface and underground mines, and disposal of wastes from mineral beneficiation and further processing. Some 47 per cent of the land affected by mining and waste disposal had been reclaimed by the end of that period (Johnson, J. and Paone, J. 'Land Utilisation and Reclamation in the Mining Industry, 1930-1980', Bureau of Mines Circular 8862, Washington, D.C., 1982)

[3] "Base metal victims of environment assault", Metal Bulletin, London, 5 November 1992. While the figure may appear enormous and is likely to be overstated, it is worth pointing out that it corresponds to less than 5 per cent of the value of world non-fuel mineral production at about the same time, in 1990 (UNCTAD: Handbook of world Mineral Trade statistics 1990-1995 (UNCTAD/ITCD/ COM/2), New York and Geneva, 1997)

[4] The Polluter Pays Principle, as adopted by OECD countries, states that "the polluter should bear the expenses of carrying out pollution prevention and control measures decided by public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption." (Organisation for Economic Co-operation and Development: The Polluter Pays Principle: Definition, Analysis, Implementation, Paris, 1975) ◆

Environmental impacts of trade liberalization and policies for the sustainable management of natural resources: a case study on Chile's mining sector

Abstract

As interactions between countries increase and the world faces globalization of the economy, there is widespread concern about the effects the ongoing process of trade liberalization will have on the environment. But the question is, how to assess the environmental effects of trade liberalization. UNEP undertook a case study on Chile's mining sector reviewing the most important factors influencing both thinking and assessment of the impacts of trade on the environment and assessing the implications of the findings and proposed recommendations for action.

Résumé

L'objet de cet article est de décrire le raisonnement à suivre pour mettre en oeuvre un projet pour financer la fermeture de mines dans des économies en transition, pendant que ces mines sont encore en activité et font des profits, afin de réduire leurs attentes et dépendences vis-à-vis des gouvernements et donateurs pour résoudre ce problème. Cet article souligne aussi la nécessité d'un programme d'assistance technique s'addressant aux pay- qui y participe, pour les aider à développer les principes et structures réglementaires appropriés.

Resumen

A medida que aumenta la interacción entre los países y el mundo se enfrenta a la globalización de la economía, existe una preocupación generalizada acerca de los efectos del actual proceso de liberalización del comercio sobre el medio ambiente. La pregunta es cómo evaluar los impactos ambientales de la liberalización del comercio. La UNEP tomó un caso de estudio del sector minero chileno y revisó los principales factores que determinan tanto el pensamiento como la evaluación de los impactos del comercio sobre el medio ambiente y evaluó las implicancias de las conclusiones y las recomendaciones propuestas.

The context of the debate

As interactions between countries increase and the world faces globalization of the economy, there is widespread concern about the effects the ongoing process of trade liberalization will have on sustainable development and, in particular, on the environment. After years of perceived contradictions between free trade and environmental protection, a common perspective was agreed upon at the 1992 United Nations Conference on Environment and Development (UNCED or the Rio Conference). There governments endorsed the call to address the issue and "make international trade and environmental policy mutually supportive". This was strengthened at the Rio+5 discussions in 1997 when governments stressed once again that "decisions on further liberalization should take into account effects on sustainable development".

Various international and national bodies have undertaken specific initiatives to address the interaction between trade and environment. In fact, environmental review and assessment has been identified as a key mechanism for achieving integration between trade and environment policies. In practical terms however, co-ordination and action to enhance policy integration has been fairly limited. The question is then, how to assess the environmental effects of trade liberalization and at the same time, devise appropriate policies to correct negative impacts. But beyond that, the question is how governments can contribute to integrating concerns for the environment in policies related to economic development and trade and correct market failures to assign adequate values to environmental resources.

UNEP study

UNEP undertook a case study on Chile's mining sector utilizing local experts in Chile. The 1999 Report reviewed the most important factors influencing both thinking and assessment of the impacts of trade on the environment; reviewed the overall economic and environmental impacts resulting from trade liberalization in the mining sector in Chile; and, assessed the implications of the findings and proposed recommendations for action. Some of the key findings follow.

Lessons from the Mining Sector in Chile

The Chilean experience

The introduction of neo-liberal policies in Chile in the early 1970s was accompanied by deliberate moves to lessen the role of the state, create a favorable climate for private investment, open up the economy and increase trade exchanges. This process coincided, internationally, with an overall expansion of the world economy and increasing globalization.

This conjunction led to a remarkable growth in the Chilean economy, fuelled to a great extent by exploitation of natural resources at an ever increasing rate. This has affected the quality of the environment and even raises questions as to the long-term sustainability of this pattern of economic development.

Following this process through the case of the Chilean mining sector, it is possible to establish a chain of casual events that have led to the current impacts on the environment:

- The process of economic liberalization in Chile resulted in the opening up to world markets and a freeing of trade and economic exchanges; this in turn resulted in a marked growth in exports in the mining sector;
- Increased trade, in turn, resulted in structural changes in the mining sector as well as in a shift in production patterns and changes in the type of products exported;
- Scale effects resulting in great part from trade, contributed to increasing environmental pressure which, in terms of waste disposal, site abandonment, social and economic sustainability of mining communities and water scarcity is a significant concern;
- External factors – e.g., the lobbying of the United States copper producers not to allow Chilean copper in the market, in terms of environmental dumping, or the pressure by multinational com-

panies on the Chilean authorities to obtain clear environmental regulations – have played a significant role in environmental management in the Chilean mining sector and have influenced the manner in which these impacts were perceived and dealt with, spurring the government to set in place a regulatory framework to address environmental impacts:

- At the same time, trade liberalization also encouraged transfer of more environmentally effective management practices and technologies to deal with the emerging environmental impacts;
- Improved environmental regulation, management and technologies are allowing, and in future will continue to allow, reduction of the negative environmental effects of mining activities per unit of production, thereby offsetting at least part of the effects of growth;
- Although the information available makes an overall environmental balance difficult, the increase in production and trade of mining products is responsible for the following negative impacts and concerns: waste disposal (especially solid waste), social and economic sustainability of mining communities, water scarcity, site abandonment; environmental progress, on the other hand, has been achieved with respect to air and water quality; and,
- Ultimately, because the mining sector is based on a non-renewable resource, its activities will be greatly reduced and then cease; abandonment of mining sites may leave a legacy of residual environmental problems.

This step-by-step review of the findings of the study shows clearly that trade liberalization has indeed had an important and negative environmental impact, but that countervailing forces – also directly linked to the liberalization process – are contributing to their mitigation.

Managing the environmental effects of trade

Experience in Chile shows that, to date, the most effective way of addressing the environmental impacts of mining activities has been through regulation and improved technology. Although both factors are operating reasonably well, there is room for further improvement and for specific actions to support and extend the beneficial influences.

It is therefore suggested that additional measures be undertaken, principally by the government, although the private sector can also make a significant contribution to their implementation. Only the main categories of activities that should be addressed will be suggested here.

Environmental policy framework: It would be desirable to develop an explicit policy framework to deal with environmental issues, that would give purpose and direction to the various initiatives and provisions that currently exist. Among the main elements that should be considered is the introduction of a long-term perspective to development policy and the integration of economic, social and environmental elements within it. This framework should inform government activities, including legally binding agreements connected to trade – for example, when negotiating the proposed accession of Chile to NAFTA.

Environmental planning and management: Going beyond the current approach to environmental protection that focuses principally on point intervention and regulation, the introduction of a broad system of regional planning and management, covering entire ecosystems or river basins, would allow to deal with the interactions between different environmental pressures and the competing demands of economic sectors more effectively. This approach would also make systematic collection of data on the environment and monitoring changes over time feasible.

Environmental regulatory framework: It is desirable to rationalize both the regulatory system as well as the associated institutional structures. As part of this move, a comprehensive set of norms and standards for environmental quality should be developed, including not only the present thresholds on pollutants, but also indicators of ecosystem integrity and status of biota and habitats.

Development and transfer of technology: These two elements have been shown to be the most effective means of integrating environmental protection with economic activity. Setting in place explicit provisions to encourage this to take place at a larger scale, both within the mining sector as well as throughout the economy, would contribute to enhancing environmental protection.

Specific action programmes: The development of a strategy to ensure the transition towards a more sustainable pattern of development in mining areas should be seen as a priority. This would entail exploring development of other forms of economic activity that do not rely solely on non-renewable resources. Other supportive actions could be to undertake studies on how to address the historically accumulated impacts of mining and issues of similar strategic importance.

Financing of environmental protection: This could be secured by the creation of a fund specifically for this purpose. The mechanisms employed to build up the fund will depend on many factors, but possible options include reform of the tax regime and direct contributions by the mining sector.

Understanding the implications of trade liberalization

Having examined the effects on the environment of trade liberalization, it might be useful to reflect on the broader implications. Is it possible to extend the same kind of analysis to the overall effects of trade liberalization in the mining sector on Chilean society as a whole? What is the nature of these effects? Are they, on balance, positive or negative? It might appear a rhetorical question, because trade liberalization is undoubtedly beneficial – but in what circumstances, at what price?

Based on the experience in the mining sector, we might frame some questions. Trade liberalization has undeniably influenced the direction and growth of the Chilean economy. But how has the overall economy benefited? How much has trade served to stimulate national internal growth and employment? How much has it contributed to the welfare of Chileans? What are the long-term prospects for the country? What is the long-term significance of the growing dependence on foreign investment and foreign ownership of productive resources?

These points apply to the case of the mining sector in Chile. But it would seem that there is a more general mechanism of cause and effect at work, which applies not only to other economic sectors, but to the overall economy of Chile, and of other countries as well.

These questions need to be addressed primarily as a means of pinpointing weaknesses and identifying where effects might be negative in the long term. Only then will it be possible to manage the process of trade liberalization so that it can truly benefit the country, and people, rather than the global economy – that somewhat elusive entity of ever moving investment and profit that feeds on itself.

Looking to the Future: Towards an Improved Policy Framework

Addressing effects of trade

It seems clear that trade liberalization has a series of effects that need to be examined. It is useful to understand what the specific effects are – on the environment, on the economy, on the social fabric of countries. But these factors also need to be considered as a system.

To date, the tendency has been to focus on trade principally from the economic point of view. This is natural, in that trade is after all an economic activity. But we know that this economic activity has far reaching consequences that affect both social and environmental factors. Thus, the practice of giving primacy to the economic dimension of trade, and, in the best of circumstances, dealing with the other effects in side agreements, no longer seems desirable.

If we consider the many cases when the economic dimension of trade has been given primacy over social considerations (as in the case of the WTO ruling against the EU's ban on hormone-treated beef) or the environment (as in the GATT ruling on tuna import restrictions), we see that this approach is ultimately self-defeating.

If we accept that the economy is an instrument to promote human welfare, not an end in itself, then this imbalance between the weight accorded to the different dimensions of trade needs to be redressed.

Moving towards policy integration

It is becoming increasingly recognized that it is necessary to integrate the various dimension of development – including trade. Efforts towards greater policy integration are already under way, but need to be extended and applied more vigorously.

A deterrent to progress in this endeavor is the complexity of integrating the disparate elements in a world that is organized along sectoral lines. All levels of human endeavor, and all stages of decision-making are sectoral. The current approach is to try and achieve integration at the level of action by trying to reach a balance among

competing interests and needs, all of which are legitimate within their own bounds. Often, none is served adequately, or the strongest sector has primacy. This is what is happening at present, where economic factors are acquiring an ever growing influence over all other aspects of society.

A way to address this dilemma may be to integrate the various interests and needs at the initial stage of policy formulation – that is, where goals are defined. At this level, goals should refer to the overall goals of society – not to the narrow, purely sectoral ones. The problem is that these very broad goals are seldom defined explicitly – they constitute the unspoken direction of society. But because they are not explicit, because they are not defined in a stringent manner, they are often overlooked, and indeed, society inadvertently moves counter to them.

Recognizing this problem, it would seem possible to state these broad goals explicitly, and from there to devise a broad strategy – the focus of the actions of society. From there, it is possible to devise an integrated policy framework that gives a balanced direction to sectoral policies. It is not the place here to describe all the intricate steps towards putting such a framework in place. Indeed, there is abundant advice as to how this must be done. Just to name one instance, Agenda 21, the internationally recognized strategy for sustainable development, outlines such a framework, most notably when describing the means to integrate environment and development in decision-making.

This framework should also inform trade policy, and steps need to be taken to ensure, on a global level, that trade agreements are truly balanced and not favoring one need against another. The steps towards this are perhaps complex, but certainly clear. What is lacking, is the collective will to reach balance. Recognizing this is the first step to achieving this balance.

Notes

(adapted from 1999 UNEP report. For more information, please contact: Hussein Abaza, Chief, Economics and Trade Unit, DTIE, UNEP, 15 chemin des Anémones, CH-1219 Chatelaine, Geneva. Email: hussein.abaza@unep.ch)

◆

◆◆◆◆◆

Small-scale and artisinal mining

Worldwide, extensive small-scale mining, sometimes called artisinal mining represents the livlihood of some 11 to 13 million people in 55 countries in 1999. This is a significant increase from the 6.0 million estimated in 1993. Of these, some 250 million are children between the ages of 5 and 14, half of them full time and tens of millions of them in exploitive and harmful conditions

The term *small-scale mining* covers both operations involving individual miners or families and larger mechanized operations although a precise definition in unavailable. Few small-scale miners have any formal mining skills although many unfortunately have a lot of experience. They are generally not organized although both training and organization into small groups is occurring in places (see the story on small scale miners video project in South Africa). In addition, there are positive interactions between small-scale and large mines taking place in countries like : Bolivia; Namibia; Zimbabwe; Ghana and Venezuela

With this global workforce of 11-13 million, the International Labour Organization estimates that, bearing in mind extended families in many countries and a small multiplier effect, this number could approximate 80-100 million, about the same number of workers who depend on large-scale mining. Small-scale mining is precarious both to the environment and to the health, safety and hygiene of the workers.

Gold is the main substance extracted. Gold and gemstones worth $1 billion per year are estimated to be produced from sub-Saharan Africa. In China, gold production from small-scale mining is worth about $200 million; in Bolivia and Brazil about $180 million; $140 million in Indonesia; and, about $250 million in Peru. In countries where sales are not transparent and smuggling is rife, benefits are lost to the government and, in most cases, the commodities pass through several hands at discounted prices before reaching the formal market. This means that the artisinal miners generally receive less than half the value of their production.

Children involved in small-scale mining: Africa.

Environmental Impacts

The environmental impacts of small scale mining in-clude the destruction of vegetation, hydrological disruption, noise and air pollution and severe contamination of surface and underground waters

Pressure on the environment as well as on worker health is particularly great with respect to gold mining because of the use of mercury. A June 2000 mercury spill in a community near the operations of the Yanacocha Mining Company, Peru resulted in some 200-300 people being hospitalized because they did not understand that mercury is toxic. Mining is often carried out in an archaic fashion with no concern being shown for the areas invaded or for their rehabilitation once they are mined out. This leads to the destruction of ecosystems. Furthermore, the types of mining most often used (hydralic and placer mining, river dredging, gold panning), combined with uncontrolled use of mercury in the amalgamation process causes problems which extend much further than an immediate area. ◆

Small-scale mining legislation and regulatory frameworks

Edmund Bugnosen, 73 Devonshire Rd, London E17 8QH, U.K.
John Twigg, Benfield Greig Hazard Research Centre, Department of Geological Sciences, University of College London, Gower Street, London WC1E 6BT, U.K.
Andrew Scott, Intermediate Technology, Bourton Hall, Bourton-on-Dunsmore, Warwickshire CV23 9QZ, U.K.

Abstract

Although a growing number of Third World countries are introducing laws and regulations for their respective small-scale mining sectors, these have not necessarily helped to promote the sector's growth, nor to solve some of the social and environmental problems associated with it. These are some of the main findings of a study carried out by the non-government organization Intermediate Technology, with funding from the British Government's Department for International Development. It is a pilot study on small-scale mining legislations, and is designed to provide governments and aid agencies with guidance on sustainable policy and regulatory mechanisms.

Résumé

Bien qu'un nombre croissant de pays du Tiers monde mettent en place des lois et règlements régissant les activités minières à petite échelle de leur pays, l'essor de ce secteur n'en a pas forcément été favorisé, pas plus que la résolution de certains des problèmes sociaux et environnementaux qui y sont associés. Telles sont les principales conclusions d'une étude effectuée par l'ONG Intermediate Technology grâce à des aides financières du ministère britannique du Développement international. Il s'agit d'une étude pilote des législations relatives à l'exploitation minière à petite échelle, destinée à fournir aux gouvernements et aux agences d'aide des conseils sur les politiques de développement durable et les mécanismes de réglementation.

Resumen

Si bien una cantidad creciente de países del Tercer Mundo está introduciendo leyes y reglamentaciones para sus respectivos sectores mineros de pequeña escala, éstas no han ayudado necesariamente a promover el crecimiento del sector ni a resolver algunos de los problemas sociales y ambientales asociados. Estos son algunos de los hallazgos de un estudio realizado por una organización no gubernamental denominada International Development. Es un estudio piloto sobre la legislación minera en pequeña escala, diseñado para proveer la los gobiernos y a las empresas de ayuda las políticas sustentables y mecanismos regulatorios.

Introduction

Small-scale mining makes a substantial contribution to the economic and social development of the Third World. It provides a livelihood to at least six million men and women worldwide, often complementing agriculture and other seasonal trades as well as offering a 'safety net' to people made unemployed by economic contraction or retrenchment and to subsistence farmers affected by drought. It further provides mineral products for export (including high-value minerals such as gold and gemstones) and raw materials for local use by other industries, particularly in construction and agriculture.

However, in many countries the small-scale mining sector is cut off from the mainstream of economic and industrial development. A great deal of small-scale mining activity is unregulated and in effect illegal, leading to the growth of black-market trading in minerals. Moreover, most small-scale operations are developed haphazardly, and are poorly equipped and under-resourced. This results in wasteful productive practices and hazardous working conditions with a disregard for health, safety and environmental protection.

A number of international expert meetings in recent years have concluded that the introduction of appropriate laws and policies could enhance small-scale mining's positive contributions and reduce its negative impact. These recommendations have begun to influence the development of new policies and laws or the modification of older ones. As yet, though, there has been little analysis or synthesis of the different legal and regulatory frameworks, their effectiveness and constraints on their design and implementation.

With funding from the Department for International Development's ESCOR scheme for economic and social research, Intermediate Technology's Mining Programme has carried out a preliminary research study to fill some of these gaps in knowledge and understanding.

Project aims and objectives

The project addressed three main questions. *First*, what are the constraints facing governments in developing their policies for small-scale mining, and how have they addressed these? *Second*, what impact have different policies (and their implementation) had on national and local economies, job creation and income generation among miners, their communities and the envi-

Brazil: small-scale miners

ronment? *Third*, what lessons can be learnt from past and current policies and regulations, and what general conclusions can be drawn?

The research findings were intended to provide practical benefits in a number of different ways. They will help in facilitating the development of more appropriate and effective policies, that is policies that increase the social and economic benefits of small-scale mining as well as ameliorating its damaging environmental and social impacts. The findings can also reduce the cost of developing such policies by preventing duplication of inappropriate approaches. Finally, improving the understanding of key issues among governments, donor agencies and development organizations, and contributing towards setting basic policy standards are important tasks. Also here this research can provide a valuable contribution.

The research analysis was based on laws and regulations for small-scale mining collected from 18 countries [1]. Eleven of these were in Africa, four in Asia and three in South America. The research report consists of the findings from this analysis, supplemented by individual case studies of six countries; Tanzania, Uganda, Philippines, Papua New Guinea, Ethiopia and Guinea. This following is a short summary of the main findings of the April 1998 report.

African children working as artisinal miners

Main features of the legislation

Experts have never been able to reach a generally agreed definition of 'small-scale' mining and in practice many different definitions are used. The legislation reflects this variety and uncertainty but there are some common features:

1. stakeholders are usually nationals of the country concerned;
2. the use of sophisticated equipment is restricted; and
3. there are limits set on the mine's outputs and capital investment.

For purposes of this report, 'small-scale' was understood in its broadest sense: the 'bottom end' of the mineral industry sector, undertaken either as a means of livelihood or as a business enterprise and including both formal and informal operations, as well as artisanal mining.

The laws studied, which were enacted over a number of years, exhibit a great variety of forms and approaches, of which the most important ones are outlined below. [2]

Rationale

The stated reasons for enacting legislation are diverse and wide-ranging. They include a desire to stop the negative effects of mining such as black market trading and environmental damage and more positive influences such as the wish to create jobs and generate foreign exchange earnings.

Regulating the development of small-scale mining

Most of the legislation examined is designed to assist nationals of that country, and in some countries these receive preferential access to certain areas. Nearly all the legislation recognizes the difference between extraction of minerals for commercial purposes and personal use: landowners, for example, usually enjoy free access on their own land to minerals used for building or as fertilizers.

However, there are conflicting policies where small-scale mines are transformed into larger or more formal operations. Some countries (for instance, Zambia) require holders of small-scale mining licenses to take out a different license at this point but others attempt to stop artisanal mining when it reaches a stage where it requires more advanced technologies. Elsewhere, areas originally designated for small-scale mining may be declassified and opened up to allow large-scale mining companies in.

Most countries attempt to limit the technological development of small-scale operations through restrictions on the depth of workings and the use of explosives or certain types of equipment.

Tanzania: Crushing gold ore using vehicle half-shafts as pestles and wooden mortars near Buckreef, Lake Victoria region. The siliceous dust produced is carcinogenic.

Environmental regulation

Six of the countries studied in detail require those who apply for small-scale mining rights to incorporate environmental protection plans that must be approved before a license is granted. Another four have addressed specific environmental problems associated with mining through specific provisions in the legislation itself. Some countries require bonds to be deposited in case of environmental damage, while Ghana and the Philippines levy a tax on small-scale mining output that is used to rehabilitate areas affected by the mines.

Health and safety

The Philippines is the only country studied that has separate safety regulations for small-scale mining, and this regulation was adopted only in 1997. Elsewhere, this matter is mostly covered by general health and safety legislation.

Marketing

There is no common approach to regulating the marketing of mineral products. Whilst a few countries have government controlled buying or licensing of traders, others include permission to market or export minerals as part of the individual license or permit to mine.

Penalties and incentives

A variety of penalties are in place for infringements of the laws. They range from cancellation of licenses to fines and imprisonment. Incentives are less common but include tax and royalty exemptions and government grants for prospecting.

Decentralized regulation

In five countries, local government is involved in regulation, either by issuing licenses or even managing the mineral resource itself.

Licensing Systems

Individual countries may have several types of licensing arrangement. The study identified six main forms.

- *Informal.* The laws allow mining without the need for separate applications. Landowners and indigenous people are the main beneficiaries of such provisions. Many countries' arrangements include some form of this.
- *Strata.* Rights are provided to a certain depth. Five of the countries issue such licenses but the permissible depths set vary greatly.
- *Group.* This simplified system giving rights over a specified area to cooperatives or other associations is used in the Philippines and for alluvial (riverbed) gold mining in Zimbabwe.
- *By type or name of mineral.* This is the most common kind of license, especially for gold, diamonds and gemstones.
- *Staggered and single.* Most countries issue single licenses to cover exploration, development, extraction, processing and marketing. This is a simple process and is the most appropriate for small-scale mining. However, three countries issue separate licenses for each stage in a process (known as staggered licenses), a procedure that is normally adopted only for large-scale mining.
- *National systems.* In every case except one, there is a single licensing system for the whole country, although this can be managed at local level. The exception is Brazil, where individual states can issue their own regulations and licensing procedures.

In addition, there are three other key features of mining licenses;

- *Duration.* Most countries provide only short-term licenses, for one to two years. Zambia and Ethiopia are the most notable exceptions, offering 10-year licenses.
- *Area.* Most countries provide licenses for an area of 20 hectares or less; the area may vary according to the type of mineral being mined and the legal personality of the applicant.
- *Transfers of ownership.* Small-scale mining licenses are normally treated as transferable assets.

Miners hoisting ore near Toma, northeastern Burkina Faso: There are few safety precautions with such operations.

Impact of Regulations

There is very little information on the impact of legislation. The accounts that are available are inconclusive. In Ghana, it does appear that a combination of new legislation (in 1986) and the subsequent establishment of systematic support to the sector did boost exports of some precious minerals and may have created several thousand jobs. In Brazil and Zimbabwe, however, it has been claimed that recent legislation has not led to significant improvements in the social and environmental consequences of small-scale gold mining.

Difficulties in Legislating

The main problems in legislating for small-scale mining operations occur in situations where large companies already hold permits to prospect in the areas concerned, or where permits for large-scale mining are granted in places where small-scale

miners are already at work. Where governments have addressed the problems, it has generally been by encouraging the large companies to allow small-scale miners to work parts of the claim. In many countries it is mandatory for holders of large mining concessions to gradually reduce the size of their concessions as explorations progress: small deposits of no interest to the license holders then revert back to the government which can make them available to small-scale miners.

There appear to exist conflicting provisions in some countries' mining laws. The research indicates that external assistance is still needed to strengthen local capacities in drafting such legislation.

Concluding Remarks

Five main conclusions may be drawn from the study:

- All of the 18 countries investigated in detail recognize the importance of the small-scale mining sector and the need for an appropriate regulatory framework.
- Most of the major issues to do with small-scale mining – including illegal trading, health and safety, environmental degradation, and taxation; but not labour matters – are addressed by the legislation. However, more research is needed to determine how effective such measures have been.
- The current trend in policy making is to encourage integration into the formal mining industry. In general, though, promotion of the mining sector in developing countries remains biased towards large-scale mining; with the aim of attracting foreign investment.
- Large proportions of small-scale miners continue to operate outside the regulatory framework. This suggests that they do not see advantages from the legislation, or that legal and regulatory provisions are inappropriate, or that the institutional capacity to implement such provisions is lacking.
- Small-scale mining is generally seen as a national industry that should remain in the hands of nationals of the country concerned. However, the principal motive of some countries in legislating for the sector is to regulate or control rather than encourage it. This is reflected in restrictions on the use of explosives and machinery, the short duration of licenses and the limited depth allowed for underground workings, as well as in the lack of secure tenure for small-scale miners. Such provisions constrain technological and operational improvements, and discourage planning, enterprise and protection of the environment.

South America: entire families are involved in small-scale mining

The project has succeeded in its aim of making a preliminary assessment of the subject but more research will be needed before 'good practice' recommendations for small-scale mining legislation can be developed. This research should include field observation and data gathering in-country (to compensate for the paucity of documentary evidence) and should incorporate the following aspects in particular;

- Countries in Latin America, Francophone Africa and North Africa and the Middle East.
- Understanding of the links between small-scale mining legislation and other laws (for instance, those on environmental protection).
- The institutional and administrative capacities of government agencies required to implement legislation.
- The effectiveness and respective advantages of different licensing systems that have already been adopted (including those in North America).
- The influence of different stakeholders on the development of legislation.
- Regulatory frameworks' effects on particular groups of miners (including particularly gender differences).

Notes

[1] Brazil, Burkina Faso, Chile, Ethiopia, Indonesia, Ghana, Guinea, Guyana, Laos, Mozambique, Malawi, Namibia, Papua New Guinea, Philippines, Tanzania, Uganda, Zambia, Zimbabwe.

[2] There is very little information on the historical development of policy although the documents do indicate a growing consensus on the need to legalize and formalize small-scale mining.

To obtain a copy of the full report (35 pp.), please contact Edmund Bugnosen at 73 Devonshire Road, London E17 8QH, U.K.

◆

Financial provisioning for mine closure: developing a policy and regulatory framework in the transition economies

Mehrdad M. Nazari, Principal Environmental Specialist, European Bank for Reconstruction & Development, One Exchange Square, London EC2A 2JN, U.K

Abstract

The purpose of this article is to describe the rationale for implementing a programme to secure mine closure funding in transition economies during the operational and profitable phase of mining projects and to reduce the expectation or reliance on governments and donors to address this issue. The need for a technical assistance programme to be provided to participating countries to assist them in developing the relevant policy and regulatory framework is also outlined.

Résumé

Dans de nombreuses économies en transition où l'activité minière joue un rôle important, l'absence de dispositions spéciales pour la fermeture des mines, généralement pour des questions de contraintes financières, a été et continue d'être à l'origine d'effets pervers majeurs sur l'environnement, la santé et la sécurité. Beaucoup de ces économies en transition n'ont pas encore élaboré de système évolué de gestion des entreprises, de cadre réglementaire ou de marchés de la finance et de l'assurance pour s'attaquer au problème de la fermeture des mines et à son financement. Cela se traduit par (1) des retards dans le développement de projets et les investissements dans ce secteur, (2) une répartition et une externalisation potentiellement inéquitable des coûts de fermeture des mines, (3) des solutions au coup par coup onéreuses en termes de temps et d'argent et (4) une différenciation, voire le sentiment de "pénaliser" les investisseurs qui sollicitent des aides financières ou une assurance contre les risques politiques auprès des organismes financiers internationaux.

Il faudrait lancer un programme axé sur l'élaboration d'une politique et d'un cadre réglementaire pour financer les activités liées à la remise en état et à la fermeture des mines. Une politique et un cadre réglementaire efficaces permettraient en effet de réduire la dépendance financière, volontaire ou forcée, à l'égard des gouvernements et des donateurs, et de "sauver" les régions les plus gravement touchées par les impacts à long terme de l'exploitation minière.

Resumen

En muchas Economías de Transición (EdT), donde la actividad minera es significativa, la falta de implementación de actividades de cierre de sitios mineros, generalemente debido a restricciones financieras, ha generado y continúa generando importantes impactos negativos sobre el medio ambiente y la salud. Muchos de estas EdT todavía deben desarollar gobiernos corporativos sofisticados, marcos regulatorios o mercados financieros y companías aseguradoras que contemplen el cierre de sitios mineros y aseguren su financiación. Esto lleva a i) demoras en el desarrollo de proyectos e inversiones en este sector, ii) potencial distribución no equitativa y externalización de costos de cierre, iii) soluciones particulares para cada caso, costosas y tiempo demandantes, y iv) a diferenciar, y probablemente crear la impresión de "penalizar" a los inversores que intenten asegurar riesgos financieros o políticos por medio de organismos internacionales de financiación.

Es necesario iniciar un programa para desarrollar un marco regulatorio y políticas de previsión financiera para la rehabilitación y cierre de sitios mineros. La implementación de una exitosa política o marco regulatorio reduciría la expectativa o la necesidad de depender de los gobiernos y los donantes para la asistencia financiera, "rescatando financieramente" las áreas que hayan sufrido mayores consecuencias por impactos mineros de largo plazo.

Context

In many Economies in Transition (EiT), where there are significant mining activities, the lack of implementation of mine closure activities, normally due to financial constraints, has resulted and continues to result in significant adverse environmental and health and safety impacts. In contrast to countries that have already implemented 'good international mining practices', these EiT have yet to develop a similarly sophisticated corporate governance, regulatory framework or financial and insurance markets to address mine closure and secure its funding. This leads to (i) delays in developing projects and investments in this sector, (ii) potentially inequitable distribution and externalization of closure costs, (iii) costly and time consuming tailor-made solutions on a case-by-case basis, and (iv) differentiating – and possibly creating the impression of 'penalizing' – investors seeking financing or political risk insurance through International Financial Institutions (typically requiring consideration of closure related issues) from investors accessing alternative capital markets (with more limited requirements relating to closure funding).

A programme to develop a policy and regulatory framework for financial provisioning related to mine rehabilitation and closure should be initiated. This programme would be able to assist participating countries in developing the required policy and regulatory framework to further promote and implement long-term environmentally sound and sustainable development in the mining sector. It would also contribute to reducing the uncertainties associated with post-operational practices, and possible related adverse environmental impacts and costs. It would also facilitate the introduction of a standardized approach to this issue, establishing a 'level playing field with fixed goal posts' for regulators, investors, mining companies, and operators. The implementation of such a successful policy and regulatory framework would reduce the expectation and need to rely on governments and donors for financial assistance, effectively 'bailing out' the most severely impacted areas suffering from long term mining impacts.

Background

The mining sector is a very important contributor to local and national economies, including in central and eastern Europe (CEE) and the former Soviet Union (FSU), countries in which the European Bank for Reconstruction & Development (EBRD), a multilateral financial institution, operates.

However, in parts of CEE and the FSU, the mining sector has often been characterized by planning and operational and post-operational practices that are inappropriate – including the lack of an adequate regulatory framework – and by inadequate implementation of mine rehabilitation and closure activities.[1]

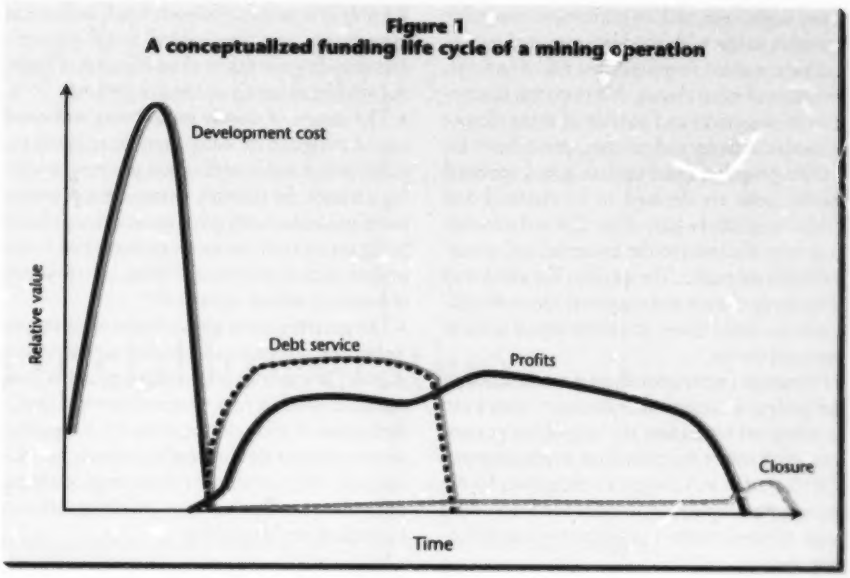
Environmental and financial concerns

Profitable mining projects have a finite life-cycle, ending when the operation becomes uneconomical or otherwise undesirable. A conceptualized

funding life cycle of a mining operation is shown in Figure 1. Gold mining, for example, may have a relatively short life-cycle of some 10-20 years. The geotechnical and geochemical nature of mining projects may result in a continuation of significant, long-term, and wide ranging environmental and health and safety impacts even after all operations are terminated. The adverse post-operational impacts associated with gold mining projects, for example, may typically include release of acid mine drainage or other liquid discharges into the environment. This, in turn, can mobilize sediments, heavy metals and reagents in nearby surface and groundwater, or generate dust containing heavy metals.[2] Mining activities, more generally, can result in a number of other potentially significant adverse environmental impacts which are not covered in this article. Examples include subsidence, impacts on biodiversity and on the lives of local and indigenous populations. These impacts can normally be controlled and mitigated by implementing a mine rehabilitation and closure programme, which should typically be outlined and costed as part of the environmental impact assessment (EIA) and the feasibility study of the mining project.

The objective of mine closure is to provide long-term stabilization of the geochemical and geotechnical conditions of the disturbed mining areas to protect public health, and minimize and prevent any additional or on-going environmental degradation. Mine closure is, typically required at a time when the operation is no longer economically viable, when cashflow is often severely restricted or negative, and when the value of assets is below the expenditures required to achieve the environmental objective of mine closure. The objective of securing mine closure funding at an early project development and implementation stage is to reduce the risk of an enterprise being either unwilling or unable to undertake mine closure due to lack of funding.

Figure 1
A conceptualized funding life cycle of a mining operation



International practice

In the absence of other regulatory requirements, accounting provision is preferred by the mining industry to address mine closure liabilities. This practice is an *accounting transaction* which allows a company to make *non-cash* provisions for future mine closure costs. However, this does not result in any actual cashflow for the purpose of accumulating closure funds or payment of related expenses. Unless the company has chosen to set aside actual funds for closure, when the project approaches the closure date closure liabilities are likely to exceed the project's and the company's tangible book values, assuming the typical scenario of a ring-fenced special purpose mining company which is operating one mining project. Any attempts to raise additional funds for closure at this stage by selling the company's assets would be unlikely to raise sufficient funds to meet the closure requirements. A 'one-project-company' may declare bankruptcy at this stage rather than attempting to raise and invest additional funds for the terminal stage of the project with no prospect of a return on such an investment. Declaring bankruptcy would 'externalize' the costs associated with mine closure and result in the financial burden being passed on to the authorities. Government funding may well be inadequate to mitigate potential long-term environmental and safety impacts.

'Good mining industry practices' in Australia, Canada, and the USA, for example, are typically guided by: industry stewardship, i.e. "self-policing" as a result of good corporate governance; following company policies and reflecting shareholder, employee, and NGO pressure; relatively recent regulatory frameworks; and sophisticated financial and insurance markets to integrate and address mine closure activities and their financing. In these countries, accounting accruals alone are typically no longer considered adequate to mitigate the risk of non-performance of mine closure activities. Instead, companies are required to secure the necessary funding by providing guarantees for mine closure funds prior to commencing construction and operation, and prior to generating any cashflow from the operation. The available guarantee options include bonding, corporate surety and guarantees, letters of credit, deposits of cash or gold, insurance and other methods. Key considerations during the selection process by both industry and regulators include the costs associated with each option, the creditworthiness, and the track record of the owner/operator.

Some environmental pressure groups or non-governmental organizations (NGOs) consider the relatively recent developments in the US,[3] – for example, requiring financial guarantees (rather than accounting accruals alone) – an invaluable step towards risk reduction of non-performance of mine closure. However, these NGOs also point out that permitting agencies in the US have commonly underestimated reclamation costs by failing to account adequately for permit violations and incidents, off-site pollution, administrative costs, and inflation. This view is echoed, to some extent, by industry consultants and mining companies who believe that a number of issues, such as the extent and period of aftercare required for post-operational activities, and the related cost estimates have often been underestimated in the past. However, they also believe that these issues are now much better understood, allowing for much more reliable definition and costing of the issues.

The Economies in Transition

In contrast to Australia, Canada and the USA, the Economies in Transition comprising Central and Eastern Europe (CEE) and the Former Soviet Union (FSU), have yet to develop a similarly sophisticated corporate governance, regulatory framework or financial and insurance markets to address the funding of mine closure. This is further complicated by

- environmental liabilities resulting from on-going operations;
- involvement of some 'junior investors' which have, unlike many major mining companies, limited resources to back-up the mining company's obligations and, sometimes, exhibit a more limited appreciation of reputational risks;
- the involvement of state-controlled enterprises, sometimes with very limited access to financial resources and state-of-the-art know-how;
- some agreements explicitly or implicitly allocating closure related liabilities to the local partner or government towards the end of the economic life of the project, by, for example, transferring all assets;
- lack of enforcement of local environmental regulations;
- lack of awareness and influence on the part of the potentially affected public; and
- lack of transparency, as contractual arrangements addressing mine closure activities and related costs are generally treated as confidential.

Risks which may preclude mine closure

Many international financial institutions and investors as well as sponsors, borrowers, and regu-